

The University of Bradford Institutional Repository

<http://bradscholars.brad.ac.uk>

This work is made available online in accordance with publisher policies. Please refer to the repository record for this item and our Policy Document available from the repository home page for further information.

To see the final version of this work please visit the publisher's website. Access to the published online version may require a subscription.

Link to publisher's version: <http://dx.doi.org/10.3310/pgfar04060>

Citation: Wright J, Fairley L, McEachan RRC et al. (2016) Development and evaluation of an intervention for the prevention of obesity in a multiethnic population: the Born in Bradford applied research programme. Programme Grants for Applied Research. 4(6)

Copyright statement: © 2016 NIHR Health Technology Assessment Programme. Full-text reproduced in accordance with the publisher's self-archiving policy.

Development and evaluation of an intervention for the prevention of childhood obesity in a multiethnic population: the Born in Bradford applied research programme

John Wright, Lesley Fairley, Rosemary McEachan, Maria Bryant, Emily Petherick, Pinki Sahota, Gillian Santorelli, Sally Barber, Debbie A Lawlor, Natalie Taylor, Raj Bhopal, Noel Cameron, Jane West, Andrew Hill, Carolyn Summerbell, Amanda Farrin, Helen Ball, Tamara Brown, Diane Farrar and Neil Small

Development and evaluation of an intervention for the prevention of childhood obesity in a multiethnic population: the Born in Bradford applied research programme

John Wright,^{1*} Lesley Fairley,¹ Rosemary McEachan,¹ Maria Bryant,² Emily Petherick,¹ Pinki Sahota,³ Gillian Santorelli,¹ Sally Barber,¹ Debbie A Lawlor,⁴ Natalie Taylor,¹ Raj Bhopal,⁵ Noel Cameron,⁶ Jane West,¹ Andrew Hill,² Carolyn Summerbell,⁷ Amanda Farrin,² Helen Ball,⁷ Tamara Brown,⁷ Diane Farrar¹ and Neil Small⁸

¹Bradford Institute for Health Research, Bradford Royal Infirmary, Bradford, UK

²Faculty of Medicine and Health, University of Leeds, Leeds, UK

³School of Health and Wellbeing, Leeds Beckett University, Leeds, UK

⁴School of Social and Community Medicine, University of Bristol, Bristol, UK

⁵Centre for Population Health Sciences, University of Edinburgh, Edinburgh, UK

⁶School of Sport, Exercise and Health Sciences, Loughborough University, Loughborough, UK

⁷Wolfson Research Institute for Health and Wellbeing, Durham University, Durham, UK

⁸Faculty of Health Studies, University of Bradford, Bradford, UK

*Corresponding author

Declared competing interests of authors: Pinki Sahota reports a Learning Curve Grant 2011 from Danone Baby Nutrition for infant dietary analysis. Helen Ball reports consultancy work to develop and test a safe infant sleep tool for NHS Lancashire and Blackpool, consultancy work to advise on bedside sleeping promotional materials for Kindred Agency (for NCT Bednest) and a grant from the Economic and Social Research Council (ESRC) for the Infant Sleep Information Source website.

Published May 2016

DOI: 10.3310/pgfar04060

This report should be referenced as follows:

Wright J, Fairley L, McEachan R, Bryant M, Petherick E, Sahota P, *et al.* Development and evaluation of an intervention for the prevention of childhood obesity in a multiethnic population: the Born in Bradford applied research programme. *Programme Grants Appl Res* 2016;**4**(6).

Programme Grants for Applied Research

ISSN 2050-4322 (Print)

ISSN 2050-4330 (Online)

This journal is a member of and subscribes to the principles of the Committee on Publication Ethics (COPE) (www.publicationethics.org/).

Editorial contact: nihredit@southampton.ac.uk

The full PGfAR archive is freely available to view online at www.journalslibrary.nihr.ac.uk/pgfar. Print-on-demand copies can be purchased from the report pages of the NIHR Journals Library website: www.journalslibrary.nihr.ac.uk

Criteria for inclusion in the *Programme Grants for Applied Research* journal

Reports are published in *Programme Grants for Applied Research* (PGfAR) if (1) they have resulted from work for the PGfAR programme, and (2) they are of a sufficiently high scientific quality as assessed by the reviewers and editors.

Programme Grants for Applied Research programme

The Programme Grants for Applied Research (PGfAR) programme, part of the National Institute for Health Research (NIHR), was set up in 2006 to produce independent research findings that will have practical application for the benefit of patients and the NHS in the relatively near future. The Programme is managed by the NIHR Central Commissioning Facility (CCF) with strategic input from the Programme Director.

The programme is a national response mode funding scheme that aims to provide evidence to improve health outcomes in England through promotion of health, prevention of ill health, and optimal disease management (including safety and quality), with particular emphasis on conditions causing significant disease burden.

For more information about the PGfAR programme please visit the website: <http://www.nihr.ac.uk/funding/programme-grants-for-applied-research.htm>

This report

The research reported in this issue of the journal was funded by PGfAR as project number RP-PG-0407-10044. The contractual start date was in July 2008. The final report began editorial review in June 2015 and was accepted for publication in November 2015. As the funder, the PGfAR programme agreed the research questions and study designs in advance with the investigators. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The PGfAR editors and production house have tried to ensure the accuracy of the authors' report and would like to thank the reviewers for their constructive comments on the final report document. However, they do not accept liability for damages or losses arising from material published in this report.

This report presents independent research funded by the National Institute for Health Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, CCF, NETSCC, PGfAR or the Department of Health. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, NETSCC, the PGfAR programme or the Department of Health.

© Queen's Printer and Controller of HMSO 2016. This work was produced by Wright et al. under the terms of a commissioning contract issued by the Secretary of State for Health. This issue may be freely reproduced for the purposes of private research and study and extracts (or indeed, the full report) may be included in professional journals provided that suitable acknowledgement is made and the reproduction is not associated with any form of advertising. Applications for commercial reproduction should be addressed to: NIHR Journals Library, National Institute for Health Research, Evaluation, Trials and Studies Coordinating Centre, Alpha House, University of Southampton Science Park, Southampton SO16 7NS, UK.

Published by the NIHR Journals Library (www.journalslibrary.nihr.ac.uk), produced by Prepress Projects Ltd, Perth, Scotland (www.prepress-projects.co.uk).

Programme Grants for Applied Research Editor-in-Chief

Professor Paul Little Professor of Primary Care Research, University of Southampton, UK

NIHR Journals Library Editor-in-Chief

Professor Tom Walley Director, NIHR Evaluation, Trials and Studies and Director of the HTA Programme, UK

NIHR Journals Library Editors

Professor Ken Stein Chair of HTA Editorial Board and Professor of Public Health, University of Exeter Medical School, UK

Professor Andree Le May Chair of NIHR Journals Library Editorial Group (EME, HS&DR, PGfAR, PHR journals)

Dr Martin Ashton-Key Consultant in Public Health Medicine/Consultant Advisor, NETSCC, UK

Professor Matthias Beck Chair in Public Sector Management and Subject Leader (Management Group), Queen's University Management School, Queen's University Belfast, UK

Professor Aileen Clarke Professor of Public Health and Health Services Research, Warwick Medical School, University of Warwick, UK

Dr Tessa Crilly Director, Crystal Blue Consulting Ltd, UK

Dr Peter Davidson Director of NETSCC, HTA, UK

Ms Tara Lamont Scientific Advisor, NETSCC, UK

Professor Elaine McColl Director, Newcastle Clinical Trials Unit, Institute of Health and Society, Newcastle University, UK

Professor William McGuire Professor of Child Health, Hull York Medical School, University of York, UK

Professor Geoffrey Meads Professor of Health Sciences Research, Health and Wellbeing Research and Development Group, University of Winchester, UK

Professor John Norrie Health Services Research Unit, University of Aberdeen, UK

Professor John Powell Consultant Clinical Adviser, National Institute for Health and Care Excellence (NICE), UK

Professor James Raftery Professor of Health Technology Assessment, Wessex Institute, Faculty of Medicine, University of Southampton, UK

Dr Rob Riemsma Reviews Manager, Kleijnen Systematic Reviews Ltd, UK

Professor Helen Roberts Professor of Child Health Research, UCL Institute of Child Health, UK

Professor Jonathan Ross Professor of Sexual Health and HIV, University Hospital Birmingham, UK

Professor Helen Snooks Professor of Health Services Research, Institute of Life Science, College of Medicine, Swansea University, UK

Professor Jim Thornton Professor of Obstetrics and Gynaecology, Faculty of Medicine and Health Sciences, University of Nottingham, UK

Please visit the website for a list of members of the NIHR Journals Library Board:
www.journalslibrary.nihr.ac.uk/about/editors

Editorial contact: nihredit@southampton.ac.uk

Abstract

Development and evaluation of an intervention for the prevention of childhood obesity in a multiethnic population: the Born in Bradford applied research programme

John Wright,^{1*} Lesley Fairley,¹ Rosemary McEachan,¹ Maria Bryant,² Emily Petherick,¹ Pinki Sahota,³ Gillian Santorelli,¹ Sally Barber,¹ Debbie A Lawlor,⁴ Natalie Taylor,¹ Raj Bhopal,⁵ Noel Cameron,⁶ Jane West,¹ Andrew Hill,² Carolyn Summerbell,⁷ Amanda Farrin,² Helen Ball,⁷ Tamara Brown,⁷ Diane Farrar¹ and Neil Small⁸

¹Bradford Institute for Health Research, Bradford Royal Infirmary, Bradford, UK

²Faculty of Medicine and Health, University of Leeds, Leeds, UK

³School of Health and Wellbeing, Leeds Beckett University, Leeds, UK

⁴School of Social and Community Medicine, University of Bristol, Bristol, UK

⁵Centre for Population Health Sciences, University of Edinburgh, Edinburgh, UK

⁶School of Sport, Exercise and Health Sciences, Loughborough University, Loughborough, UK

⁷Wolfson Research Institute for Health and Wellbeing, Durham University, Durham, UK

⁸Faculty of Health Studies, University of Bradford, Bradford, UK

*Corresponding author john.wright@bthft.nhs.uk

Background: There is an absence of evidence about interventions to prevent or treat obesity in early childhood and in South Asian populations, in whom risk is higher.

Objectives: To study patterns and the aetiology of childhood obesity in a multiethnic population and develop a prevention intervention.

Design: A cohort of pregnant women and their infants was recruited. Measures to compare growth and identify targets for obesity prevention, sensitive to ethnic differences, were collected. A feasibility randomised controlled trial (RCT) was undertaken.

Setting: Bradford, UK.

Participants: A total of 1735 mothers, 933 of whom were of South Asian origin.

Intervention: A feasibility trial of a group-based intervention aimed at overweight women, delivered ante- and postnatally, targeting key modifiable lifestyle behaviours to reduce infant obesity.

Main outcome measures: The feasibility and acceptability of the pilot intervention.

Data sources: Routine NHS data and additional bespoke research data.

Review methods: A systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults.

Results: Routine measures of growth were accurate. The prevalence of risk factors differed between mothers of white British ethnicity and mothers of Pakistani ethnicity and weight and length growth trajectories differed between Pakistani infants and white British infants. Prediction equations for risk of childhood obesity were developed. An evidence-based intervention was evaluated in a pilot RCT and was found to be feasible and acceptable.

Limitations: This was a single-centre observational study and a pilot evaluation.

Conclusions: The programme has been successful in recruiting a unique multiethnic childhood obesity cohort, which has provided new evidence about modifiable risk factors and biethnic growth trajectories. A novel group-based behavioural change intervention has been developed and successfully piloted. A multisite cluster RCT is required to evaluate effectiveness.

Trial registration: Current Controlled Trials ISRCTN56735429.

Funding: The National Institute for Health Research Programme Grants for Applied Research programme.

Contents

List of tables	xi
List of figures	xiii
List of boxes	xv
List of abbreviations	xvii
Description of ethnic classification	xix
Plain English summary	xxi
Scientific summary	xxiii
SYNOPSIS	1
Interventions to prevent obesity	1
Born in Bradford	2
An applied research programme on childhood obesity	3
<i>Recruitment of the BiB1000 cohort to investigate childhood obesity</i>	3
<i>Modelling growth trajectories and obesity risk</i>	3
<i>Ethnic differences in obesity risk factors</i>	3
<i>Early risk factors for childhood obesity</i>	3
<i>Systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults</i>	3
<i>Investigation of social and environmental determinants of childhood obesity</i>	4
<i>Development of an obesity prevention intervention</i>	4
<i>Exploratory trial of the obesity prevention intervention</i>	4
Programme management	4
Clinical engagement	5
Patient and public involvement	5
Recruitment and data collection for the BiB1000 cohort to investigate childhood obesity	7
Modelling growth trajectories and obesity risk	9
Modelling growth trajectories	9
Development of a mobile phone app to predict childhood obesity	10
Ethnic differences in obesity risk factors	11
Ethnic differences in the initiation and duration of breastfeeding	11
Ethnic differences in infant diet (see <i>Appendix 1.1</i>)	11
Infant sleep patterns (see <i>Appendix 1.2</i>)	12
Physical activity (see <i>Appendix 1.3</i>)	12
Ethnic differences in parenting style	13
Early risk factors for childhood obesity	15

Systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults	17
Investigation of social and environmental determinants of childhood obesity	19
Investigation of social and environmental determinants of childhood obesity (see <i>Appendix 1.4</i>)	19
A mealtime observation study: obesity, ethnicity and observed maternal feeding styles (see <i>Appendix 1.5</i>)	20
Researcher-conducted home food availability inventories	21
Food outlet availability, deprivation and obesity in a multiethnic sample of pregnant women in Bradford, UK	21
Using intervention mapping to develop a culturally appropriate intervention to prevent childhood obesity: development of the Healthy and Active Parenting Programme for Early Years intervention	25
Feasibility randomised controlled trial of the Healthy and Active Parenting Programme for Early Years intervention	31
Conclusions and recommendations	35
Summary	35
Conclusions from our research	36
Recommendations for research	38
<i>BiB1000: a cohort for the study of childhood obesity</i>	38
<i>Child growth</i>	38
<i>Ethnic differences in risk factors for childhood obesity</i>	38
<i>Determinants of childhood obesity</i>	38
<i>Systematic review</i>	39
<i>Obesity intervention trial</i>	39
Acknowledgements	41
References	49
Appendix 1 Reports of studies not yet published	61
Appendix 2 Further details of data collection instruments	105
Appendix 3 Full texts of publications that are not open access	111
Appendix 4 Born in Bradford and the Twins Grow Up	157

List of tables

TABLE 1 Key intervention content: antenatal sessions **27**

TABLE 2 Key intervention content: postnatal sessions **28**

List of figures

FIGURE a Outline of programme workstreams	xxiii
FIGURE 1 The Healthy Infant Weight? app	10
FIGURE 2 Consolidated Standards of Reporting Trials (CONSORT) flow diagram of study recruitment and retention	32

List of boxes

BOX 1 Coding categories for parent behaviours	107
BOX 2 Coding categories for infant behaviours	108

List of abbreviations

BiB	Born in Bradford	MOS	Mealtimes Observation Schedule
BMI	body mass index	NICE	National Institute for Health and Care Excellence
CI	confidence interval	NIHR	National Institute for Health Research
CVD	cardiovascular disease	OA	output area
FLNP	Family Links Nurturing Programme	RCT	randomised controlled trial
GIS	geographic information systems	SDS	standard deviation score
HAPPY	Healthy and Active Parenting Programme for early Years		
MCID	minimum clinically important difference		

Description of ethnic classification

Born in Bradford is a multiethnic cohort consisting of families from around the world. However, the main ethnic groups are of South Asian origin (Pakistani, Bangladeshi and Indian) and white British origin. The large majority of the South Asian-origin families are of Pakistani origin. Much research into South Asian health and well-being combines what are often very heterogeneous ethnic groups. A strength of Born in Bradford is the homogeneity of the largest ethnic group of Pakistani origin. Methodologically and statistically, the focus of much of the work in the programme has been on Pakistani and white British comparisons. For completeness some of the analyses include a third category of 'other' ethnicities, which includes non-Pakistani and non-white British children. When we refer to the terms 'South Asian' and 'Pakistani' we are referring to families of South Asian or Pakistani origin who have been born either in the UK or in South Asia or Pakistan.

Plain English summary

There is a gap in the research evidence on effective interventions to prevent and treat obesity, particularly in early childhood and for those of South Asian origin.

The ethnic diversity of the Born in Bradford (BiB) cohort means that we were able to compare:

- birthweights and growth patterns of children of different ethnicities
- what young children eat
- what adult expectations there are around eating
- the way that adults interact with children at mealtimes.

We found ethnic differences in breastfeeding, infant diet, sleeping patterns and types of physical and sedentary activities that children engaged in:

- South Asian children were lighter at birth than white British children but gained weight and length quicker in infancy.
- South Asian and white British children were of similar weight at age 2 years but South Asian children were taller on average than white British children.
- White British mothers breastfed for less time and weaned earlier than South Asian mothers.
- South Asian mothers were less physically active and had higher rates of gestational diabetes.
- South Asian families ate more fresh fruit and vegetables and drank more sugary drinks in the home than white British families and white British infants ate more processed meats.
- Infants were more likely to be overweight/obese at 3 years if the mother was obese and also if the mother smoked during pregnancy.
- Obese mothers were most likely to use positive comments during feeding but were less likely to set limits or boundaries on what children ate.

We have used the collected evidence to develop an intervention programme that acknowledges the diversity of needs among British families and is aimed at parents whatever their ethnic or cultural background. This Healthy and Active Parenting Programme for early Years (HAPPY) has been tested in a pilot study with encouraging results.

Scientific summary

Childhood obesity is a major global public health threat that impacts on health and well-being in childhood and through to adult life. There is emerging evidence that early life environments are important in the aetiology of obesity but there is a notable gap in the research evidence on effective interventions to prevent and treat obesity, particularly in early childhood and for those of South Asian origin.

The aim of this National Institute for Health Research (NIHR) programme was to study the patterns and aetiology of childhood obesity in a multiethnic population and to use this evidence to develop a tailored obesity prevention intervention. The design and development of effective interventions requires a robust empirical evidence base to identify the right targets (modifiable behaviours) for preventing obesity and the right timing (in the growth trajectory) for implementing the intervention. We set out to measure and analyse data on growth trajectories in a multiethnic population alongside an assessment of hypothesised modifiable environmental and behavioural risk factors for obesity.

Programme workstreams (Figure a)

1. To recruit a subsample of the Born in Bradford (BiB) cohort for intensive follow-up to collect data on growth and modifiable risk factors in a deprived multiethnic community.
2. To describe ethnic differences in risk factors for childhood obesity and to identify modifiable behaviours and risk factors to target in future interventions.
3. To undertake a systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults.
4. To explore wider determinants of, and cultural differences in, feeding and eating patterns and beliefs, attitudes and practices with regard to obesity, diet and exercise.
5. To design a theory-based innovative intervention to improve modifiable behaviours in both parents and children to prevent childhood obesity.
6. To undertake a feasibility trial to evaluate the intervention.

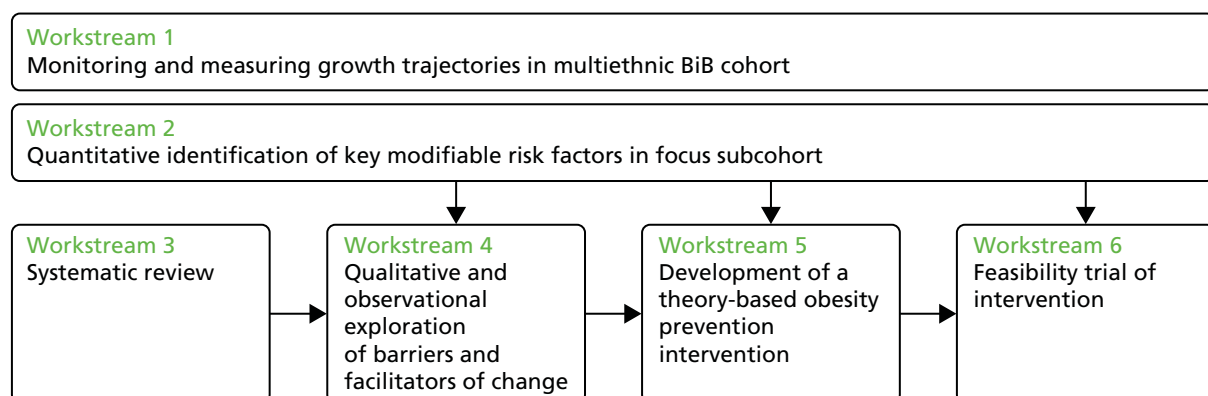


FIGURE a Outline of programme workstreams.

Methods

Workstream 1: recruitment of a childhood obesity cohort (BiB1000)

Data were collected from families during pregnancy, at birth and during early childhood. In addition to prespecified hypothesised targets for obesity prevention (diet, activity), the BiB1000 study explored qualitative determinants of behaviours and other exposures with less evidence (food environments, sleep, parenting practices).

A reliability study assessed routinely collected growth measures. Multilevel linear spline models were used to model growth trajectories and logistic regression was used to develop prediction equations to model the risk of childhood obesity.

Workstream 2: ethnic differences in risk factors for childhood obesity and association with body mass index at age 3 years

We used exposure data (feeding, parenting, diet, physical activity and sleep) from the BiB1000 questionnaires to describe ethnic differences. We used outcome data on 987 participants with body mass index (BMI) measurements at age 3 years, of whom 382 (39%) were of white British origin and 474 (48%) were of Pakistani origin. Linear regression was used to assess the association between risk factors and BMI standard deviation scores and Poisson regression was used to determine the relative risk between risk factors and infant overweight. Models included adjustment for maternal and child characteristics.

Workstream 3: a systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults

Studies of any type of lifestyle intervention of any length of follow-up that reported any anthropometric measure for children or adults of South Asian ethnicity were included in the systematic review. There was no restriction on the type of comparator, and randomised controlled trials (RCTs), controlled clinical trials and before-and-after studies were included. A comprehensive search strategy was implemented.

Workstream 4: investigation of social, cultural and environmental determinants of childhood obesity

Four methods were utilised to investigate social, cultural and environmental determinants of childhood obesity. Qualitative interviews with 14 mothers focused on decisions to breastfeed and decisions about weaning with a view to identifying personal imaginative worlds and interactional contexts in which choices were made. A further 38 mother–child dyads were observed during typical mealtimes and coded using the Mealtime Observation Schedule. Observed interactions were compared with mothers' self-reports on questionnaire assessments of feeding, parenting styles and infant characteristics. Food inventories recorded the availability of key food and drink items within a sample of 100 homes. Finally, food outlets in five contiguous inner-city wards in Bradford were identified and linked to individual-level data on a sample of 1198 women using geographic information systems (GIS) methodology to examine the association between food outlet location, deprivation, weight status and ethnicity.

Workstream 5: development of a theory-based obesity prevention intervention

Intervention mapping was applied as follows: (1) needs assessment of parents, the wider community and practitioners and consideration of the evidence base, policy and practice; (2) identification of outcomes and change objectives following identification of barriers to behaviour change; (3) selection of theory-based methods and practical strategies to address barriers to behaviour change; (4) design of the intervention by developing evidence-based interactive activities and resources; and (5) adoption and implementation: parenting practitioners were trained by health-care professionals to deliver the intervention within children's centres. The intervention was named the Healthy and Active Parenting Programme for early Years (HAPPY).

Workstream 6: feasibility trial of the Healthy and Active Parenting Programme for early Years

A feasibility RCT was conducted. A total of 120 overweight pregnant women were recruited between 10 and 26 weeks' gestation and allocated on a 1 : 1 basis to either a 12-week intervention programme (six sessions antenatally, six sessions postnatally; $n = 59$) or usual care ($n = 61$). Assessments took place at baseline and when the infant was aged 6 and 12 months and included the mother's BMI, infant's length and weight and mother's and infant's physical activity and diet. Outcomes were recruitment rate, attrition, acceptability of randomisation and measurement tools and acceptability of the intervention. Fidelity was assessed through observations and facilitator feedback. Focus groups and structured interviews were conducted with mothers to gauge their reactions to the research methods and the content of the intervention.

Results

Workstream 1: recruitment of a childhood obesity cohort (BiB1000)

A total of 1735 mothers agreed to take part in detailed assessments focused on risk factors for obesity. Of these, 1707 had singleton births. Approximately half of the mothers ($n = 933$) were of South Asian ethnicity, of whom just under half were born in the UK. The prevalence of obesity in the BiB1000 cohort was similar to that in the full BiB cohort and to UK national averages.

Pakistani boys and girls were lighter at birth and had a shorter predicted mean length at birth than white British boys and girls but gained weight and length quicker in infancy. By age 2 years both ethnic groups had a similar weight but Pakistani boys and girls were taller on average than white British boys and girls. Data-driven prediction equations for risk of childhood obesity were developed and incorporated into a mobile phone application.

Workstream 2: ethnic differences in risk factors for childhood obesity and association with body mass index at age 3 years

Pakistani mothers were more likely to initiate breastfeeding than white British mothers; however, there were no ethnic differences in exclusive breastfeeding at 4 months. Pakistani infants were more likely than white British infants to have a higher intake of sweet commercial foods, chips and roast potatoes, fruit and high-sugar drinks at 12 months. White British infants had higher intakes of savoury baby foods and processed meat products. By 18 months of age, the above differences were shown to persist and increase, indicating evidence of early tracking of consumption patterns. Pakistani infants had later sleep onset and wake times than white British infants at both 18 and 36 months. There were no ethnic differences in total daily physical activity or sedentary time; however, there were differences in the types of physical and sedentary activities undertaken. Pakistani mothers were less likely to adopt a hostile approach to parenting.

There were consistent associations between maternal smoking, maternal booking BMI, feeding style and parenting style and greater mean BMI at age 3 years and a higher relative risk of being overweight or obese at this age. There was no strong evidence that the relationship between the risk factors and BMI differed by ethnic group.

Workstream 3: a systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults

Twenty-nine studies were included in the systematic review, seven of children, 21 of adults and one of mixed-age participants. Meta-analysis of a limited number of controlled trials found an unclear picture of the effects of interventions on BMI in South Asian children. Meta-analysis of a limited number of controlled trials showed that interventions resulted in a significant improvement in weight for adults but no significant differences in BMI and waist circumference. One high-quality study in South Asian children found that a school-based physical activity intervention that was delivered within the normal school day and which was culturally sensitive was effective. There was also evidence of culturally appropriate

approaches to, and characteristics of, effective interventions in adults, which we believe could be transferred and used to develop effective interventions in children.

Workstream 4: investigation of social, cultural and environmental determinants of childhood obesity

There were many competing and contradictory sources of advice for mothers with new babies. Professional concerns about obesity had not translated into parental concerns about growth in their child. There were differences between South Asian and non-Asian mothers in terms of both meal structures and mother–child interactions. South Asian mothers used negative parenting behaviours more frequently and less positive behaviour. In the healthy-weight South Asian group this was paralleled by greater levels of negative child behaviour. Availability of foods in the home was similar between ethnic groups except for fresh fruits and sugar-sweetened beverages, which were available in greater quantities in homes of Pakistani mothers. More than 95% of all participants lived within 500 m of a fast-food outlet. Women in higher areas of deprivation had greater access to fast-food outlets and to other forms of food shops. Contrary to hypotheses, there was a negative association between BMI and fast-food outlet density in close proximity (250 m) to the South Asian group.

Workstream 5: development of a theory-based obesity prevention intervention

The HAPPY intervention was developed using an intervention mapping approach. The programme is aimed at pregnant women (BMI ≥ 25 kg/m²) and consists of 12 \times 2.5-hour sessions (six antenatal sessions from 24 weeks and six postnatal sessions up to 9 months). It addresses (1) the mother's diet and physical activity, (2) breastfeeding or bottle-feeding, (3) infant diet and parental feeding practices, (4) infant physical activity, and (5) parenting practices: parenting styles and skills.

Workstream 6: feasibility trial of the Healthy and Active Parenting Programme for early Years

The recruitment rate of women screened with a BMI of ≥ 25 kg/m² was 30% ($n=120/396$). Retention at 12 months was 66% for the intervention group and 75% for the control group. Of the 59 allocated to the intervention, 26 (44%) attended at least one antenatal appointment (attending on average 4.8 sessions) and 18 (31%) attended at least one postnatal session (average 4.6 sessions). Group clustering was minimal. An adjusted effect size of -0.25 standard deviation weight score at 12 months (95% confidence interval -0.16 to -0.65) favouring the intervention was observed.

Conclusions

This programme has established a new childhood obesity cohort with longitudinal data collection to develop a deep and extensive understanding of the predictors and influences of health-related behaviours and help develop a feasible and appropriate culturally specific intervention for the prevention of obesity. A unique quality of this cohort is its ethnic composition, which is generalisable to other large multiethnic cities in the UK. Importantly, the cohort also provides a unique foundation for the study of the long-term consequences of growth and weight through linkage with primary care health data for child health outcomes and educational attainment.

For the first time in the UK we estimated South Asian growth trajectories and found that Pakistani boys and girls were lighter and had a shorter predicted mean length at birth than their white British counterparts but gained weight and length quicker in infancy. By age 2 years both ethnic groups had a similar weight but Pakistani boys and girls were taller on average than white British boys and girls. These differences in postnatal growth were not explained by maternal height, smoking during pregnancy and gestational age. We also developed data-driven prediction equations for risk of childhood obesity and incorporated them into a mobile phone application.

We found ethnic differences in breastfeeding, infant diet, sleeping patterns and the types of physical and sedentary activities that the children engaged in. There was also evidence of dietary patterns that emerged at 12 months tracking to 18 months, indicating that, once established, these patterns may become ingrained and difficult to change. There was little evidence that parenting styles differed between ethnic groups.

Smoking during pregnancy, maternal BMI, feeding style and parenting style were all associated with infants' BMI at age 3 years. The associations between these risk factors and childhood BMI did not vary by ethnicity. Interventions to reduce childhood obesity should target smoking and maternal weight in the antenatal period and postnatally should encourage the adoption of warmer, less hostile parenting styles and responsive feeding styles.

Our systematic review concluded that there was no evidence that interventions were more or less effective according to whether or not they were targeted at South Asian families or that they differed in terms of effectiveness according to the socioeconomic status of the recipients. In addition, there was evidence of culturally appropriate approaches to, and characteristics of, effective interventions in adults, which we believe could be transferred and used to develop effective interventions in children.

Our qualitative and observational studies identified a major gap in the cultural appropriateness of current measures or existing interventions for South Asian families. Interventions need to consider how parents, in particular mothers, negotiate between the many factors that influence their behaviour, including cultural and family influences. That negotiation will be aided by interventions that support the development of self-efficacy and which offer support in how to evaluate the wide variety of advice that parents receive. Knowledge of the types and quantities of foods and drinks in family homes supports the development of intervention programmes that target an improvement of the foods available, both for obesity prevention or management and for overall diet improvement. Specifically, increasing the consumption of fruit and vegetables and reducing the consumption of sweetened drinks, crisps and biscuits should be a target. The stronger association between deprivation and fast-food density than with obesity argues for more detailed accounts of the obesogenic environment that include measures of individual behaviour. The proliferation of fast-food outlets has public policy relevance and should be considered in planning applications.

Intervention mapping provided a feasible approach to developing a complex health behaviour change intervention (HAPPY). The framework was used to produce a transparent and replicable intervention whereby mechanisms of change can be investigated and identified and strategies used to manipulate them can be appropriately refined. Integration with the existing Family Links Nurturing Programme enabled the expertise of existing parenting programme co-ordinators to be utilised to deliver the programme, thus increasing sustainability.

The HAPPY intervention was evaluated in a feasibility RCT and was found to be feasible and acceptable. However, the recruitment rate was low and attrition between randomisation and intervention attendance was high. Qualitative interviews with women who chose not to attend intervention sessions identified strategies to recruit and retain women in these types of sustained complex interventions. A proposal for a full multisite cluster RCT has incorporated these strategies and has been submitted for funding to evaluate the cost-effectiveness of the HAPPY intervention.

Trial registration

This trial is registered as ISRCTN56735429.

Funding

Funding for this study was provided by the Programme Grants for Applied Research programme of the National Institute for Health Research.

SYNOPSIS

Childhood obesity is a major global public health threat.^{1,2} Although overweight and obesity prevalence in some groups of children may be flattening or decreasing,^{3–5} overall prevalence remains high, particularly in children from minority ethnic groups.^{6,7} Evidence from the UK and the USA shows that the prevalence of overweight and obesity in preschool children is > 33%.^{8–10} Obesity acquired in childhood has been shown to persist into adulthood with over half of obese children growing up to be obese adults.¹¹ It is estimated that the direct cost of obesity to the NHS will be £2B by 2030 if the current trends continue.¹² The 2007 Foresight report¹³ estimated that the direct and indirect costs of child and adult obesity would rise to £27B by 2015.

Childhood obesity has a major impact on health and well-being in childhood and through to adult life.^{14–17} Obese children experience poor health-related quality of life and low self-esteem¹⁸ and, although the contribution of obesity towards the risk of negative health outcomes such as cardiovascular disease (CVD) and diabetes is complex, evidence suggests a consistent positive association.^{19,20}

Children of South Asian origin are at particular risk of overweight and obesity, demonstrating greater central adiposity and insulin resistance than their European-origin counterparts for a given body mass index (BMI).^{21–24} Evidence suggests that this fat–thin insulin-resistant phenotype is present at birth and that pregnancy is an important window of opportunity for obesity prevention.^{25,26} The adoption of Western urban lifestyles that result from migration to the UK has the potential to increase the risk of rapid postnatal growth and obesity contributing to the higher risks of diabetes and CVD.

There is emerging evidence that early life environments are important in the aetiology of obesity.²⁷ Maternal gestational weight gain and gestational glucose metabolism, together with greater birthweight and rapid postnatal growth, are all associated with later obesity, although it is unclear if this is driven by causal mechanisms.^{28–32} Infant weight gain is consistently associated with subsequent risk of childhood and adult obesity and this risk is particularly high for infants with very rapid weight gain [> 1.33 standard deviation score (SDS) or two centile band crossings].³³ However, it is the social, behavioural and environmental influences on childhood obesity that offer most potential for modification of factors influencing obesity.^{34–38} A recent review of systematic reviews of early determinants of obesity identified the following factors associated with an increased risk of childhood obesity: maternal smoking, short sleep duration, < 30 minutes of daily physical activity, consumption of sugar-sweetened drinks, screen viewing and parental feeding practices.³⁹ Importantly, however, the evidence of causality is not clear.⁴⁰ Thus, although reinforcement of positive health interventions such as breastfeeding should be encouraged, there is still much to learn regarding the impact it has on childhood obesity.

Interventions to prevent obesity

Despite the public health threat of obesity there is a notable gap in the research evidence on effective interventions to prevent and treat obesity, particularly in early childhood and in South Asian populations.⁴¹

Systematic review evidence^{42–49} has found that efforts to prevent obesity have shown disappointing results, which may be for the following reasons:

1. intervention schemes not guided by a robust evidence-based development process and not rooted in behaviour change theory
2. intervention strategies not tailored to the most important and modifiable behaviours
3. inadequate strategies to change family, environmental and extrinsic factors in combination with health education strategies aimed at personal behaviours
4. lack of careful pre-testing and formative evaluation procedures before larger-scale implementation
5. lack of involvement of stakeholders in intervention development, resulting in reduced engagement.

One explanation for the disappointing results of randomised controlled trials (RCTs) in terms of reducing obesity in schoolchildren is that they begin too late. Body composition and feeding patterns may become established in infancy, providing a potentially critical period for intervention.⁵⁰ Systematic reviews of obesity prevention in early childhood provide support for targeting interventions in early childhood but highlight the limited quantity and quality of the mostly US research.^{45,46} Specific gaps in the evidence include the lack of family studies and studies that attempt to improve professional–family interaction, the dearth of evidence on the effectiveness of interventions in ethnic groups and the absence of economic evaluations.

There is a good theoretical⁵¹ and empirical^{33,36,52–56} basis for developing obesity prevention interventions in early childhood as unfavourable health behaviours are established in early childhood and are good predictors of subsequent behaviours. It is likely, therefore, that early childhood provides a unique and circumscribed opportunity to promote health and prevent obesity. However, there is a paucity of evidence about safe and effective interventions in preschool children.⁵⁷ A systematic review of studies to prevent obesity in children aged 0–5 years found that interventions varied widely although most were multifaceted in their approach.⁵⁸ These interventions have been found to be feasible and acceptable and there was evidence to suggest that behaviours that contribute to obesity can be positively impacted in this age group, particularly with the involvement of parents and the targeting of skills and competencies rather than just knowledge. A systematic review of qualitative studies on behaviours related to childhood obesity found that many parents felt that strategies to promote healthy weight should start in early life and also identified the importance of targeting the wider family rather than the parents alone.⁵⁹ Studies have also suggested that an intervention delivered within a parenting programme that focuses on parenting skills and style will have an enduring impact on the development of children's healthy eating and activity patterns.^{60,61}

Born in Bradford

This programme harnessed the research potential of the new Born in Bradford (BiB) study, a longitudinal multiethnic birth cohort study aiming to examine the impact of environmental, psychological and genetic factors on maternal and child health and well-being.⁶² Bradford is a city in the north of England with high levels of socioeconomic deprivation and ethnic diversity. Approximately half of the births in the city are to mothers of South Asian origin. Women were recruited to the BiB study while waiting for their glucose tolerance test, a routine procedure offered to all pregnant women registered at the Bradford Royal Infirmary at 26–28 weeks' gestation. For those consenting, a baseline questionnaire was completed during an interview with a study administrator.

The baseline questionnaire for the mothers was transliterated into Urdu and Mirpuri using a standardised process so that words and phrases corresponded to the original English version. As Mirpuri does not have a written form, trained bilingual interviewers administered the transliterated questionnaires to Mirpuri speakers.

The full BiB study recruited 12,453 women during 13,776 pregnancies between 2007 and 2010 and the cohort is broadly characteristic of the city's maternal population. Ethical approval for the BiB1000 data collection was granted by the Bradford Research Ethics Committee (reference number 07/H1302/112).

An applied research programme on childhood obesity

The aim of this National Institute for Health Research (NIHR) programme was to study the patterns and aetiology of childhood obesity in a multiethnic population and use this evidence to develop a tailored obesity prevention intervention.

The design and development of effective interventions requires a robust empirical evidence base to identify the right targets (modifiable behaviours) for preventing obesity and the right timing (in growth trajectory) for implementing the intervention. We set out to measure and analyse data on growth trajectories in a multiethnic population alongside assessment of hypothesised modifiable environmental and behavioural risk factors for obesity. Our intention was to determine whether or not the relative impact of any modifiable risk factor differs between South Asian and European-origin populations and to assess whether or not mechanisms for change differ between communities.

This monograph describes the results of our findings linked to the original programme objectives (a full list of publications arising from our programme of work can be found in *Acknowledgements, Publications*).

Recruitment of the BiB1000 cohort to investigate childhood obesity

- Objective 1a: a 10% subsample of the BiB cohort was recruited for intensive follow-up to collect data on modifiable risk factors and growth. Data were collected from the 10% subsample through home visits by bilingual researchers, who administered survey instruments for behavioural measures and undertook anthropometry assessments.

Modelling growth trajectories and obesity risk

- Objective 1b: the programme established research-calibre routine data collection on growth monitoring in a deprived, biethnic population through strengthening routine surveillance and monitoring growth trajectories.

Ethnic differences in obesity risk factors

- Objective 2a: the focus for this objective was to describe ethnic differences in obesity risk factors to inform a culturally sensitive intervention.

Early risk factors for childhood obesity

- Objective 2b: the focus for this objective was to identify modifiable behaviours and environmental risk factors that could be targeted in future interventions.

Systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults

- Objective 3: the focus for this objective was to conduct a systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults.

Investigation of social and environmental determinants of childhood obesity

- Objective 4: the focus for this objective was to determine appropriate intervention targets. Qualitative interviews, observational methods, geospatial mapping and nutritional audits were undertaken to explore determinants of feeding practices; cultural and social differences in feeding practices; the influence of key stakeholders; beliefs, attitudes and practices in relation to obesity, diet and exercise; perceptions in the South Asian community about childhood obesity; access to fast-food retailing; and eating patterns.

Development of an obesity prevention intervention

- Objective 5: evidence from current and previous interventions was supplemented by a survey of nationally relevant work. Intervention mapping was used to select an appropriate theoretical foundation, identify change objectives and design the intervention and implementation. Field testing of candidate components for an intervention strategy was undertaken to test their feasibility and acceptability.

Exploratory trial of the obesity prevention intervention

- Objective 6: the ultimate aim of the programme was to design an innovative community/family-based intervention to improve modifiable behaviours in both parent and child. The aim of the exploratory trial was to inform a definitive (Phase III) randomised trial that could be implemented within the NHS. The exploratory trial assessed the feasibility and acceptability of the intervention; eligibility, consent and recruitment rates; the acceptability of the randomisation process; and follow up rates. Outcomes were collected to inform the components and delivery of the intervention, estimate the effect size and test and validate outcome measures.

Programme management

A quarterly steering group of all 12 co-applicants and additional expert advisors was established to oversee the implementation of the research programme. An independent trials management group consisting of Julie Walker (clinical manager), Kim Cocks (statistician and triallist) and Tracy Wood (local authority parenting expert) was established in 2012 to provide monitoring and scrutiny of the feasibility trial.

Helen Ball and her team from Durham University joined the programme to support the study of sleep in early life. Aziz Sheikh and his team at Edinburgh University joined the programme to support the development of a culturally adapted intervention. Kate Tilling and Laura Howe from Bristol University joined the programme to provide expertise in the use of multilevel linear spline and latent class modelling of early life trajectories. Darren Greenwood from Leeds University joined the team to provide support for the dietary analysis. Kath Kiernan from York University provided expert support for the exploration of the association of parenting practices with obesity. Sally Barber from the Bradford Institute for Health Research joined the team to provide expertise on physical activity.

Clinical engagement

The programme was set up to promote strong clinical engagement in the research. Such engagement was fundamental to the success of the programme. Support from health visitors from Bradford District Care Trust was required to ensure high-quality additional routine postnatal measurements. Support from the midwives at Bradford Teaching Hospitals NHS Foundation Trust was required for the successful recruitment of pregnant women to the pilot trial. Close involvement of local dieticians and public health consultants was required for the development of the intervention. Finally, close partnership with Barnado's and Family Links was essential for the delivery of the intervention.

Patient and public involvement

The BiB1000 study has benefited from extensive experience of patient and public involvement within the Bradford Institute for Health Research. This has included the use of a panel of 10 people representing the local patient community who meet regularly (3-monthly) to participate in all stages of the research process, including identifying priorities, helping to write lay summaries, reviewing methodology and supporting translational work. Panel members work in pairs to provide peer support but also meet collectively to discuss general and specific issues. The BiB study has a strong focus on wider community engagement, with regular newsletters, birthday cards, picnics and art exhibitions. One of the great strengths of the study is the close involvement of the photographer Ian Beesley and the poet Ian McMillan, whose work is featured here and in the appendices of this report.

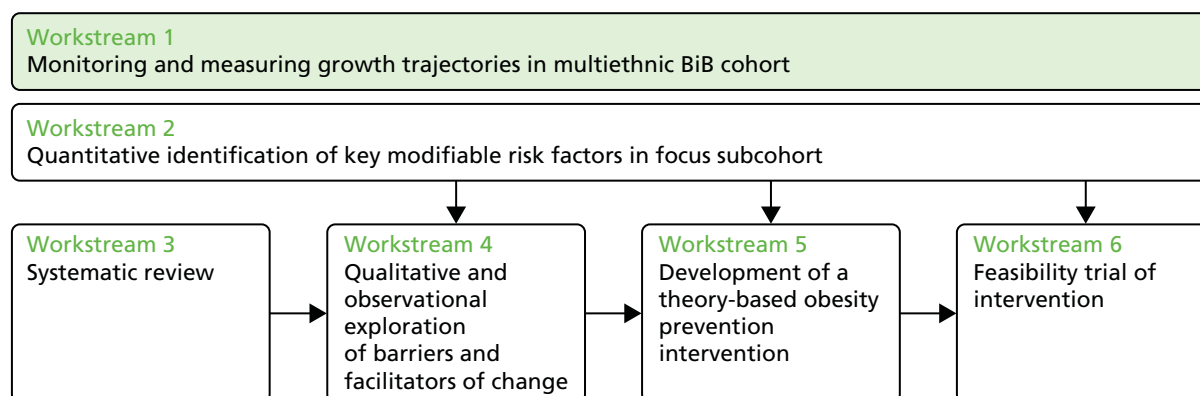
www.borninbradford.nhs.uk

 @BiBresearch (Twitter, Inc., San Francisco, CA, USA)

 Born in Bradford (Facebook, Inc., Menlo Park, CA, USA) (www.facebook.com/BornInBradford/)



Recruitment and data collection for the BiB1000 cohort to investigate childhood obesity



The BiB1000 study was established to help enable a deep and extensive understanding of the predictors of and influences on health-related behaviours and to develop a culturally specific obesity prevention intervention. Here we describe the methodology and characteristics of the study participants; this work has been published as a separate paper.⁶³

All mothers recruited to the full BiB study between August 2008 and March 2009 who had completed the baseline questionnaire were approached to take part in the BiB1000 study during their routine 26- to 28-week glucose tolerance test. Those not attending this appointment were approached elsewhere during routine hospital attendances. A sample size of 1080 was calculated based on the ability to detect a clinically significant difference in infant growth of 0.67 SDS (one centile band) in weight at age > 1 year. Based on data from the Cole UK charts,⁶⁴ we needed a minimum sample of 36 participants in any analysis group for length and a minimum of 67 participants for weight ($\beta = 0.80$; $\alpha = 0.05$). Stratification by gender and ethnicity meant that we required a minimal sample of 280 at the completion of the preschool study. Allowing for a 5% annual attrition rate, we therefore required a total sample of 1080 births. However, to account for the higher anticipated attrition rate in a deprived multiethnic population, the plan was to oversample the population by up to 60%. Ethical approval was obtained from the Bradford Research Ethics Committee (reference number 07/H1302/112) and all participants provided written informed consent prior to inclusion in the research.

Bilingual study administrators who were trained in anthropometry collected baseline information from mothers using a structured questionnaire in the home, at hospital-based clinics and at local children's centres. Participants were followed up at 6, 12, 18, 24 and 36 months.

The questionnaire measures included were selected based on hypothesised correlations with exposures and childhood obesity. As this was an exploratory study in a largely untested population, many of these hypotheses were driven by a combination of evidence from 'similar' populations in the literature and agreement by the scientific and clinical teams. Baseline data collection for the BiB study was pilot tested with a group of expectant mothers in the Bradford Royal Infirmary Maternity Unit for clarity, duration and acceptability. Except for assessment of dietary intake in infants, additional follow-up measures were not piloted in advance of data collection. However, their acceptability was determined within the BiB1000 cohort and amended as appropriate. The intended food frequency questionnaire for infants was pilot tested in children's centres and this led to slight modifications to the clarification of items to ensure that foods were culturally representative (e.g. chapattis included within bread products).

Infant weight was measured at birth by midwives and infant head circumference, mid-upper arm circumference, abdominal circumference, subscapular skin fold and triceps skin fold were measured within the first 24 hours following delivery by paediatricians and midwives who were trained in measurement techniques according to written guidelines.

Postnatal measures of infant weight, length, head circumference and abdominal circumference were collected as part of routine practice by health visiting teams. Additional measures of weight, length, head circumference, abdominal circumference and skinfolds were taken by specially trained BiB1000 study health workers at follow-up visits.

Maternal weight was measured at all assessments, maternal height was measured at baseline and BMI was derived from the antenatal booking weight (at ≈ 12 weeks of pregnancy) and baseline height.

The majority of the demographic data were obtained using structured questionnaires. Items were generated and modified from the Millennium cohort study,⁶⁵ Growing up in Australia,⁶⁶ the 2001 census⁶⁷ and the European Prospective Investigation into Cancer and Nutrition (EPIC)⁶⁸ questionnaires.

Behavioural measures were collected as part of the structured administered follow-up questionnaires, including feeding style and practices, parental and infant diet, mental health, parental and infant activity, sleep patterns, home food availability, parenting practices and other health behaviours (e.g. smoking, alcohol consumption). Validated questionnaires were used when available, although appropriate ethnic modifications were made and tested using expertise within Bradford (e.g. diet questionnaires were modified based on 24-hour recall data collected from parents in Bradford alongside input from Bradford dietitians).

A full set of questionnaires used for all follow-up assessments can be found on our website [see www.borninbradford.nhs.uk/research-scientific/general-study-documentation-and-questionnaires-2/ (accessed 4 February 2016)].

Qualitative and objective methodologies were employed in subsamples to explore the lifestyles, behaviours and environments in this multiethnic population, including (1) food outlet mapping, (2) home food availability inventories, (3) a mealtime observation study of maternal feeding styles and (4) interviews with families. Further details of the methods and findings for each of these are provided in *Investigation of social and environmental determinants of childhood obesity*.

Out of 1916 eligible women, 1735 (91%) agreed to take part in the study. Of these, 28 mothers gave birth to twins. Descriptive statistics are provided here for singleton births only ($n = 1707$). In total, 77%, 75%, 74%, 70% and 70% of participants were followed up at 6, 12, 18, 24 and 36 months respectively; 47% of participants completed all of the assessments to date, with 17% ($n = 294$) formally withdrawing from the research. Participants who could not be contacted (or when the visit could not be scheduled) were not considered to be lost to follow-up unless a withdrawal form had been completed (i.e. withdrawal of consent, death or change of residence outside the area). Thus, in some instances, data are missing at one time point but are available at subsequent visits. The greatest factor that impacted on attrition rates was the inability to make contact with participants to book appointments.

The characteristics of the BiB1000 cohort were similar to those of the full BiB cohort,⁶² with a similar distribution of age, marital status and parity. Overall, 38% of women were of white British origin and 47% were of Pakistani origin; 41% of Pakistani women were born in the UK and, of the remainder who were born elsewhere, 24% moved to the UK before the age of 18 years. Around 20% of the sample questionnaires were administered in languages other than English, reflecting this migration pattern. Demographic differences by ethnicity within the BiB1000 cohort were also observed, with white British mothers tending to be younger, educated to a lower level and less likely to be married or cohabiting and having fewer children than mothers from other ethnic groups. More than 20% of Pakistani women had more than three children prior to the birth of the study infant. Correspondingly, household size for South Asian women, especially

Pakistani women, was greater than that for other ethnicities. Infant gender, gestational age and proportion of preterm infants were similar between ethnic groups. Similarities were also observed for the mode of delivery and the proportion of stillbirths. Over 35% of white British women reported smoking during pregnancy compared with 4% and 3% of women of Pakistani and 'other' South Asian origins respectively. The proportion of women with gestational diabetes was greatest in the South Asian ethnic group, with a 10.5% prevalence in Pakistani women compared with a 5.5% prevalence in white British women.

Longitudinal data collection from the BiB1000 birth cohort has provided a sample for the NIHR programme to develop a deep and extensive understanding of the predictors and influences of health-related behaviours to help develop feasible and appropriate culturally specific intervention(s) for the prevention of childhood obesity. This was facilitated by experienced, enthusiastic, multilingual data collection staff. A unique quality of this cohort is its ethnic composition, with successful recruitment of approximately 50% of women from South Asian origin and a representative sample of women from across the socioeconomic groups within Bradford.

Modelling growth trajectories and obesity risk

Growth during infancy is an important indicator of health and well-being.⁶⁹ Evidence suggests that the obesity epidemic begins in early childhood and that the risk of obesity is greater in children who put on more weight in early life. Growth data for the BiB1000 cohort are available from two sources; the BiB1000 visits and the routine measurements recorded in health visitor records (Personal Child Health Record or 'red book'). We assessed how reliable the data collected by health visitors in Bradford are by using a test-retest reliability study and investigated the agreement between data collected in the BiB1000 clinics and the routine data collected by health visitors. This work has been published in two separate papers.^{70,71}

We found that, in Bradford, following training, health workers can in general reliably measure child growth. The technical errors of measurements obtained in our study were comparable to those from other research studies and all coefficients of reliability were indicative of good quality control. We also found that there was good agreement between BiB1000 measurements and routine measurements, although wide limits of agreement between data sources may be observed.

The growth data collected as part of the BiB1000 study supplemented with routine measurements collected by health workers in the community have provided a comprehensive reliable data set to investigate growth in infancy. We have focused on investigating ethnic differences in growth trajectories and on the development of obesity risk in childhood. We used multilevel linear spline models with repeat measures of weight and length to describe growth trajectories for white British and Pakistani infants from birth to 2 years of age and to assess whether or not there are ethnic differences in these growth trajectories. Finally, we described the development of prediction equations to identify children at risk of obesity and integrate the equations into a novel user-friendly mobile phone application. This work has been published in two separate papers.^{72,73}

Modelling growth trajectories⁷²

For the first time in the UK we estimated weight and length growth trajectories between birth and 2 years for Pakistani boys and girls and found that Pakistani boys and girls were lighter and had a shorter predicted mean length at birth than their white British counterparts but gained weight and length quicker in infancy. By age 2 years both ethnic groups had a similar weight, but Pakistani boys and girls were taller on average than white British boys and girls. Differences in maternal height explained some of the differences in weight and length at birth; however, adjustment for maternal height, smoking during pregnancy and gestational age did not explain the differences in postnatal growth rates.

Given the relationship of early postnatal growth to normal development and adult health, together with known anthropometric differences at birth in South Asian compared with white European infants, it is important to understand how size differs in this group in the postnatal period and what factors might explain these differences. The faster growth in South Asian children shown in our study could be beneficial for their early infant/childhood health as observed in low-income countries.⁷⁴ However, if the greater rate of weight gain in this population is driven by greater fat gain it may have adverse long-term consequences for cardiometabolic health⁷⁵ and contribute to the increased risk of diabetes and CVD observed in South Asian adults.^{76–78} South Asian children have been shown to be fatter for a given BMI than their European counterparts and markers of diabetes and CVD risk are increased in South Asian children and adolescents, suggesting that this faster early growth may indeed be contributing to adverse later cardiometabolic health.^{24,79,80} We acknowledge that further replication of our findings by others and longer-term follow-up to examine associations with a range of early life and later outcomes will be required to clarify the importance of these ethnic differences in growth.

Development of a mobile phone app to predict childhood obesity⁷³

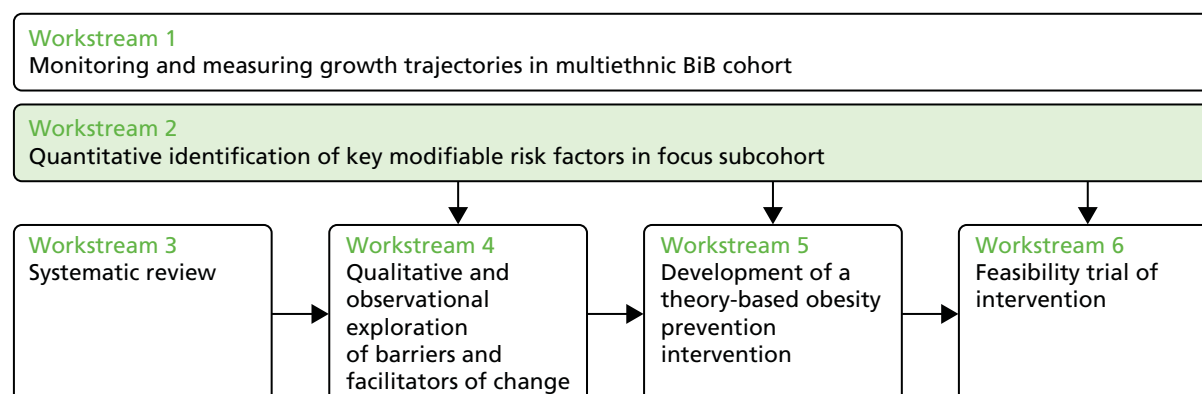
Innovative strategies to identify infants at the greatest risk of childhood obesity are necessary for the prevention of obesity. We present the development of a practical mobile phone app (*Figure 1*) that can be used for a wide range of ages (4.5–13.5 months) in infancy when growth monitoring is part of routine health care.⁸¹ The app requires information on a baby's sex, date of birth, birthweight and current weight and users can optionally add maternal height and weight (to calculate BMI). We chose not to include ethnicity and gestational age because, although they were significant predictors, neither of these factors was significant in the internal and external validity analyses. Furthermore, ethnicity in our sample was restricted to white British and South Asian ethnicities and it was felt that this would not reflect the ethnic diversity (or lack thereof) in many areas. Maternal BMI was a significant predictor in the 6- and 9-month equations but, again, this information may not be available and so we developed two sets of prediction equations so that the app would work whether or not maternal BMI was available, with a negligible effect on the model fit.

In the future the app could be developed to incorporate any number of other functionalities, such as plotting of growth measurements on a growth chart, geospatial mapping of an infant's obesity risk score compared with those of his or her peers and administration of an obesity prevention programme for those infants identified as being at high risk.



FIGURE 1 The Healthy Infant Weight? app.

Ethnic differences in obesity risk factors



Epidemiological evidence has highlighted the importance of a number of exposures in pregnancy and early life that are associated with the development of obesity in childhood. In this study we investigated ethnic differences in five early-life risk factors for childhood obesity that are modifiable and can be targeted in future interventions. The risk factors considered were (1) breastfeeding, (2) infant diet, (3) infant sleep, (4) physical activity and (5) parenting style. The work on breastfeeding and parenting style has been published in two separate papers;^{82,83} the full reports for the other risk factors are presented in *Appendix 1*.

Ethnic differences in the initiation and duration of breastfeeding⁸²

Compared with white British mothers, we found that mothers in all other ethnic groups examined were significantly more likely to initiate breastfeeding and continue any breastfeeding until their infant was 4 months of age, which is consistent with previously reported findings from the UK.^{84,85} However, we found no significant differences by ethnicity after adjustment for covariates in the rates of exclusive breastfeeding at 4 months.

Ethnic differences in infant diet (see *Appendix 1.1*)

Analyses of dietary patterns found that, by 12 months of age, foods and drinks high in sugar and foods high in fat were consumed by infants. There was no fruit and vegetable consumption in 3% of infants; a higher intake of sweet commercial foods, fruit and high sugar drinks in Pakistani infants; and higher intakes of savoury baby foods and processed meat products in white British infants.

In comparison to intakes of key indicator food groups at 12 months, the 18-month data showed large statistically significant and nutritionally concerning increases in the consumption of unhealthier food items across the cohort. Large increases were observed in the intake of chips, processed meat products, savoury snacks and sugar-sweetened drinks. Encouragingly, the intake of fruit, vegetables and low-sugar drinks had also increased.

At 18 months Pakistani infants had a higher intake of chips, roast potatoes or potato shapes and consumed substantially less processed meat than white British infants. Pakistani children continued to drink more sugar-sweetened drinks and more pure fruit juice than their white British counterparts.

There were ethnic differences in the consumption of key nutrients and these also changed over time. These changes in diet may simply reflect different weaning strategies between the ethnic groups, with Pakistani babies breastfed for longer, reflected in lower protein and fibre intakes at 12 months, but patterns relating to the consumption of solid food becoming more established by 18 months.

This analysis contributes to the limited evidence on dietary patterns in early childhood and highlights ethnic differences in some consumption patterns. There was evidence of dietary patterns that emerged at 12 months tracking to 18 months and, once established, these may form the basis of an unhealthy diet that may become ingrained and difficult to shift. This information helps us to characterise early-life dietary patterns and will allow us to examine how early diet influences later outcomes. It can be used to inform the development of community-tailored and culturally appropriate obesity prevention interventions aimed at improving the nutritional health of infants, toddlers and children.

Infant sleep patterns (see *Appendix 1.2*)

We found ethnic differences in night-time sleeping patterns, with later sleep onset and wake times for Pakistani infants than for white British infants at both 18 and 36 months and with Pakistani infants experiencing a shorter maximum sleep duration. Ethnic differences in sleeping arrangements may be affecting infant sleep duration or maternal knowledge of infant sleep duration. For example, South Asian families tend to practise familial co-sleeping, with all children sharing a room with their parents for sleeping, whereas white British families practise separate sleeping arrangements, often with one child per room. Such differences may affect maternal knowledge of an infant's sleep duration such that South Asian mothers may be more likely to be aware of night wakings. Sleep duration may also be affected if family members are more frequently disturbed by one another in the night.

Physical activity (see *Appendix 1.3*)

The majority of children in the BiB1000 cohort at age 2 years were meeting the Chief Medical Officer's guideline of 180 minutes of physical activity each day.⁸⁶ There were no differences between the ethnic groups in total time spent on daily physical activity and, in addition, sedentary behaviour and television/DVD viewing were high for the whole group (on average 1.5 hours per day). There were, however, ethnic differences in the types of physical and sedentary activities that the children engaged in. White British children were reported to spend longer walking, in organised physical activity, playing outside and in proactive sedentary behaviours (e.g. being read to) than Pakistani children, who spent longer each day playing inside and in passive sedentary behaviour (watching television/DVDs). The differences in time spent in different types of activities may result in important lifestyle differences as the children grow up as observational studies have shown that time spent outdoors correlates with physical activity levels in school-aged children.^{87,88} Time outdoors has also been associated with higher objectively measured physical activity levels^{89,90} and with a lower prevalence of overweight.⁸⁹ There were other marked differences between the ethnicities in possible determinants of physical activity and sedentary behaviour that may also contribute to the reported differences between ethnic groups later in childhood.⁹¹ These included Pakistani children being less frequently restricted in their television viewing, having more barriers to physical activity and receiving less frequent support to be physically active from their parents.

Ethnic differences in parenting style⁸³

There were no ethnic differences in parental self-efficacy and parental warmth; however, Pakistani mothers reported feeling more confident about their parenting abilities and were less likely to adopt a hostile approach to parenting. To our knowledge, no such data have been reported previously for UK-resident women and further work is needed to link these parenting styles with children's current and future health. Women of both ethnic groups with more self-efficacious, warm and less hostile parenting styles reported significantly fewer problems with their infant's temperament.

Understanding of these ethnic differences in modifiable risk factors has implications for the effective cultural adaptation of interventions to reduce childhood obesity.

Early risk factors for childhood obesity

In the last section we described ethnic differences in five early-life risk factors for childhood obesity. Here, we investigate the association between several early-life modifiable risk factors for childhood obesity and infant BMI at 3 years of age. This work has been published as a separate paper.⁹²

It is important to understand whether or not modifiable characteristics are related to BMI in infancy to ensure that appropriate interventions are developed to promote maintenance of healthy BMI levels into mid-childhood, when important relationships to future coronary heart disease risk emerge. Furthermore, knowing whether or not associations differ between South Asian- and white European-origin infants is important in knowing whether or not interventions should target different risk factors in these groups to reduce the ethnic differences in risk. In this section we describe the differences in the prevalence of potentially modifiable risk factors for childhood obesity between infants of white British origin and infants of Pakistani origin and investigate the association between these risk factors and childhood BMI measured at 3 years of age. We also examine possible ethnic differences in associations between the risk factors and child BMI.

We found that the prevalence of early-life risk factors for a higher BMI differed between mothers of white British ethnicity and mothers of Pakistani ethnicity. White British mothers were more likely to smoke during pregnancy (28% vs. 4%), have a higher BMI (obese: 24% vs. 16%), breastfeed for a shorter duration (> 4 months: 20% vs. 29%) and wean earlier, whereas Pakistani mothers had a higher rate of gestational diabetes (14% vs. 7%) and were less active (sufficiently active: 26% vs. 57%). There were consistent associations between BMI z-score and maternal smoking [mean difference in BMI z-score 0.33, 95% confidence interval (CI) 0.13 to 0.53], maternal obesity (0.37, 0.19 to 0.55), indulgent feeding style (0.15, -0.06 to 0.36), lower parental warmth scores (0.21, 0.05 to 0.36) and higher parental hostility scores (0.17, 0.01 to 0.33). Associations with mean BMI were the same for white British and Pakistani infants, with the exception of breastfeeding duration. Although we did not have sufficient statistical power to examine ethnic differences in the associations of risk factors with relative risks of overweight/obesity, the similarity in the associations with mean BMI between the two ethnic groups suggests that differences on a binary scale are unlikely.

Consistent with other studies we found that children of mothers who smoked during pregnancy were more likely to have a higher BMI SDS and a greater risk of being overweight,^{40,93,94} as were infants of overweight and obese mothers.^{28,93,95}

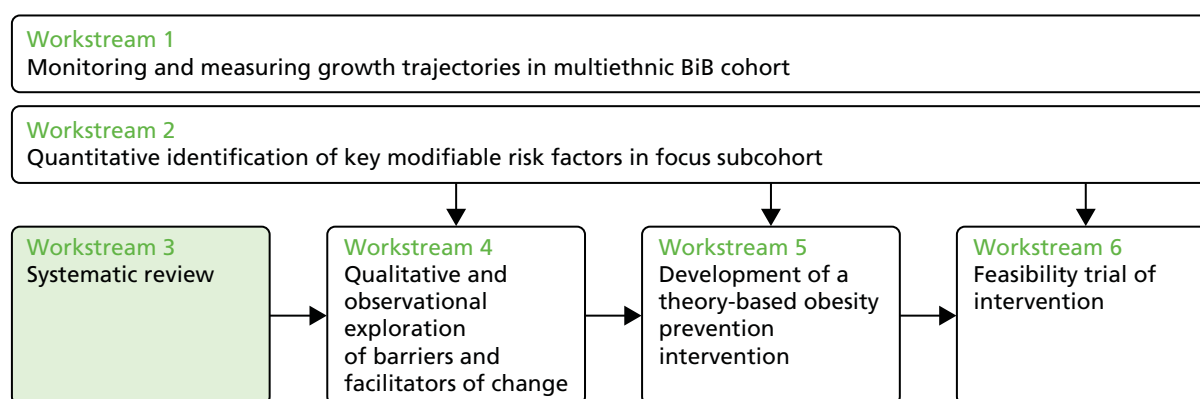
We found that certain aspects of feeding and parenting style were associated with a child's BMI. Caregivers with an 'indulgent' feeding style had infants with a higher BMI SDS and who were more likely to be overweight; this is consistent with other studies.^{96,97} Children of parents with less warm and more hostile parenting styles were more likely to be overweight. Different measures and constructs of parenting styles have been previously studied; however, evidence linking the specific domains analysed in the current study to childhood BMI is scarce, although some studies have looked at associations with dietary and activity behaviours.^{98,99} Evidence suggests that children raised by authoritative parents had lower BMI levels than children raised with other styles.⁹⁸

In this study we did not find strong evidence of an association between gestational diabetes, age at weaning, infant energy intake, infant protein intake and infant sleep duration and infant mean BMI or risk of overweight at age 3 years, despite evidence of associations between these risk factors and BMI in other studies.^{40,93,100-104} However, many of these studies were conducted in older age groups and in non-UK populations with different ethnic compositions to that of the BiB study population.

The main strength of this analysis is that we have considered several key modifiable risk factors that have been collected longitudinally during pregnancy and infancy in a multiethnic cohort. To our knowledge this is the first time that these risk factors have been studied in early infancy in infants of Pakistani origin. The limitations of the study are that it was undertaken in a single centre and so may lack generalisability. The questionnaire relied on self-report to collect information on risk factors and there may have been reporting or social desirability bias.

This work adds to the literature on the role of the early life environment and later childhood obesity and is useful in identifying suitable targets for obesity prevention interventions in infancy. It has highlighted key differences in early-life risk factors between white British and Pakistani mothers and so has highlighted the importance of cultural adaptation of interventions. It has also helped identify key modifiable risk factors to target in pregnancy and postnatally.

Systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults



The previous workstreams identified the important modifiable determinants of obesity to form targets for intervention and identified key differences in the patterns of these risk factors by ethnicity and socioeconomic status. These findings highlight the need for culturally sensitive interventions to be developed.

We performed a systematic review to identify evidence that could inform the development of an obesity prevention intervention for pregnant South Asian women and their children aged < 6 years. This systematic review has been published¹⁰⁵ and is freely available at www.mdpi.com/1660-4601/12/1/566 (accessed 1 February 2016).

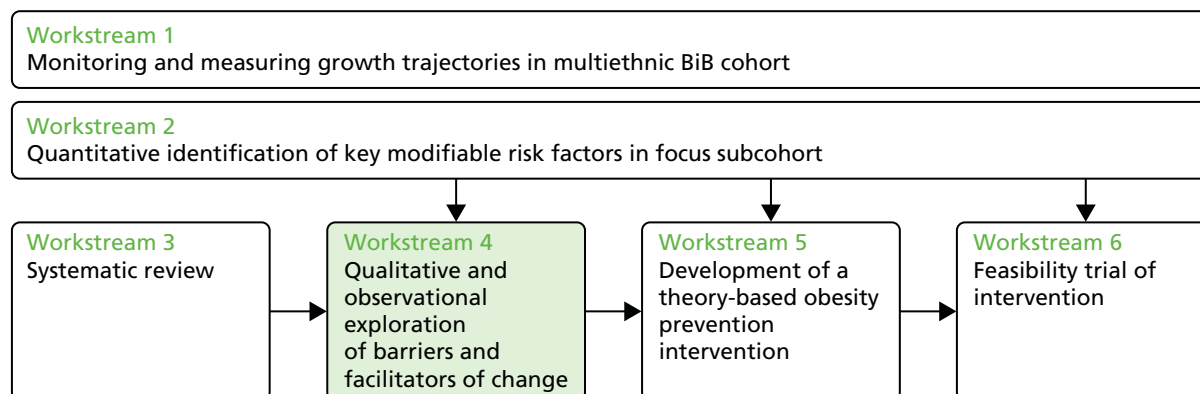
The metabolic risks associated with obesity are greater for South Asian populations than for white or other ethnic groups and levels of obesity in childhood are known to track into adulthood. Tackling obesity in South Asian populations is therefore a high priority. The rationale for this systematic review was the suggestion that there may be a differential effect of diet and physical activity interventions in South Asian populations compared with populations of other ethnicities. The research territory of the present review is an emergent rather than a mature field of enquiry, but it is urgently needed. Thus, the aim of this systematic review and meta-analysis was to assess the effectiveness of diet and physical activity interventions to prevent or treat obesity in South Asian populations living in or outside South Asia and to describe the characteristics of effective interventions.

Systematic reviews of any type of lifestyle intervention, of any length of follow-up that reported any anthropometric measure for children or adults of South Asian ethnicity were included. There was no restriction on the type of comparator and RCTs, controlled clinical trials and before-and-after studies were included. A comprehensive search strategy was implemented in five electronic databases: Applied Social Sciences Index and Abstracts (ASSIA), Cochrane Controlled Trials Register (CCTR), EMBASE, MEDLINE and Social Sciences Citation Index. The search was limited to English-language abstracts published between January 2006 and January 2014. References were screened and data extraction and quality assessment were carried out by two reviewers. The results were presented as a narrative synthesis and meta-analyses were carried out.

In total, 29 studies were included, seven in children, 21 in adults and one in a mixed-age population. No studies in children aged < 6 years were identified. Sixteen studies were conducted in South Asia, 10 in Europe and three in the USA. Effective or promising interventions included physical activity interventions in South Asian men in Norway and in South Asian schoolchildren in the UK. A home-based, family-orientated diet and physical activity intervention improved obesity outcomes in South Asian adults in the UK when adjusted for baseline differences. Meta-analyses of interventions in children showed no significant differences between intervention and control groups for BMI or waist circumference. Meta-analyses of adult interventions showed a significant improvement in weight in data from two trials when adjusted for baseline differences (mean difference -1.82 kg, 95% CI -2.48 to -1.16 kg) and in unadjusted data from three trials following sensitivity analysis (mean difference -1.20 kg, 95% CI -2.23 to -0.17 kg). Meta-analyses of adult interventions showed no significant differences between intervention and control groups for BMI and waist circumference. Twenty of 24 intervention groups showed improvements in adult BMI from baseline to follow-up; the average improvement in high-quality studies ($n = 7$) ranged from 0.31 kg/m² to -0.8 kg/m². There was no evidence that interventions were more or less effective according to whether or not the intervention was set in South Asia or by socioeconomic status.

Meta-analysis of a limited number of controlled trials found an unclear picture of the effects of interventions on BMI for South Asian children. Meta-analyses of a limited number of controlled trials showed significant improvements in weight for adults but no significant differences in BMI and waist circumference. One high-quality study in South Asian children found that a school-based physical activity intervention that was delivered within the normal school day and which was culturally sensitive was effective. There was also evidence of culturally appropriate approaches to, and characteristics of, effective interventions in adults that we believe could be transferred and used to develop effective interventions in children.

Investigation of social and environmental determinants of childhood obesity



To further explore the impact of social and environmental factors on health we conducted a range of further focused studies. The aim was to understand how these factors might constitute determinants of childhood obesity, how they might vary according to mothers' ethnicity and how they might be modified, with a view to informing any subsequent intervention. Specific areas of focus were parental attitudes to eating and infant growth, interactions that accompany mealtimes and the availability of certain foods in the home and in the neighbourhood. The work on food availability in the home and in the neighbourhood has been published in two separate papers;^{106,107} the full reports for the other topics are presented in *Appendix 1*.

Investigation of social and environmental determinants of childhood obesity (see *Appendix 1.4*)

Fourteen mothers ($n = 9$ Pakistani and $n = 5$ white British mothers) were recruited and interviewed when their infant was aged between 3 and 5.5 months. Issues around perceptions of a 'healthy baby', breastfeeding and weaning and sources of support were explored. Transcripts and field notes were independently coded by two authors. Analysis sought to identify emerging themes using a thematic narrative approach;¹⁰⁸ differences between ethnic groups were explored.

There was considerable shared ground between white and Pakistani mothers in relation to how they perceived a 'healthy' baby. Mothers expressed some anxiety about very underweight babies, but a concern about them being overweight was not strongly evident. For younger children who might be overweight the expectation (hope) was that 'they will grow out of it'; for older children the problem was seen as being a cosmetic one rather than primarily a health concern.

At the time of interviewing, only three mothers were still breastfeeding. Approximately half of the remaining mothers had tried to breastfeed, averaging between 1 week and 10 days, and had then stopped. The most common reason why they had stopped was that the 'baby was not getting enough food'. Most of the mothers interviewed were weaning already, often starting at around 4 months. Mothers were aware that there was guidance from health visitors about the correct time to wean. Some had heard advice from health visitors about baby-led weaning, but none reported trying this.

With regard to sources of advice and support there were two strong and inter-related themes: the importance of consistent advice and the many sources of advice that were available. Mothers received

inconsistent advice from different professionals about breastfeeding and between professionals and family members in relation to weaning. Adding to this challenge was the wide range of sources used for advice (e.g. extended family, friends, midwives and health visitors).

In summary, the interviews provided data that were consistent with those previously reported in the literature.⁵⁹ Parental perceptions are developed through interactions with a range of sources of influence including family, friends and health professionals. The internet was of increasing prominence as a source of information. There was not a clear hierarchy of influence.

A mealtime observation study: obesity, ethnicity and observed maternal feeding styles (see *Appendix 1.5*)

Having identified the importance of parent and family beliefs in decisions to breastfeed and wean in early infancy, we sought to explore how feeding patterns were influenced by the shared family environment. Parents are key role models for their children, socialising children to their food choices, eating habits and feeding behaviours. Parenting styles have been shown to impact on eating behaviour and outcomes related to obesity.⁹⁸ General parenting styles have been summarised as having two dimensions: control/demandingness and warmth/responsiveness.^{109,110} These independent dimensions yield four different parenting styles: authoritarian, authoritative, permissive and uninvolved parenting. Research has linked authoritative feeding styles to increased consumption of fruit and vegetable products.¹¹¹ However, many authors question whether these styles are invariant across different cultural groups.¹¹² There is an absence of research regarding parenting styles of social Asian families, especially those living in the UK. International studies regarding ethnicity and feeding practices are similarly limited.

The current study aimed to explore the influence of maternal weight and ethnicity on observed mealtime interactions. Twenty obese mothers (10 Asian and 10 non-Asian mothers) and 18 'healthy weight' mothers (8 Asian and 10 non-Asian mothers) participating in the BiB1000 study consented to take part in the study along with their children. Children were aged between 18 months and 2 years, 24 were male and 14 were female.

Mothers were asked to prepare an ordinary meal for their child on the day of the observation. The mealtime was recorded and recordings were analysed using the Mealtime Observation Schedule (MOS).¹¹³ The schedule codes parent behaviours as positive (e.g. praise, positive contact) or negative (e.g. negative eating comments) and child behaviours as positive (e.g. 'self-bites', appropriate verbal behaviour) or negative (e.g. refusing food, leaving the table). Validated questions assessing caregiver feeding style (authoritative, authoritarian, indulgent and uninvolved),¹¹⁴ parenting practices (self-efficacy, warmth and hostility⁶⁶) and infant characteristics (adaptability, fussiness/difficultness, dullness and predictability)¹¹⁵ were administered at 6, 12 and 24 months as part of the standard schedule of measurement of the BiB1000 cohort.⁶³

Analyses found that South Asian mothers presented food more times to their child than non-Asian mothers. Meal duration was shortest for children whose mothers were South Asian and of healthy weight and longest for children whose mothers were non-Asian and of healthy weight.

South Asian mothers exhibited significantly less positive behaviours and significantly more negative behaviours during mealtimes than non-Asian mothers. Children with South Asian mothers demonstrated marginally greater levels of negative behaviours during mealtimes, with no difference in positive behaviours between the two ethnic groups. Children of South Asian, healthy-weight mothers spent more time 'away from the table' than children in the other groups. There were no effects of maternal weight on these measures.

In summary, there were no differences in parenting styles of feeding behaviours by maternal weight. Distinct ethnic differences were apparent, both in the physical organisation of mealtimes (more South Asian mothers did not sit their child in a chair or use a table for mealtimes) and in the types of interactions during mealtimes (with South Asian mothers showing slightly reduced positive behaviours and slightly increased negative behaviours). This is consistent with the observation that their children demonstrated less independent eating. Overall, the results indicate that South Asian mothers exert a different *type* of control during mealtimes with their children by giving a greater number of specific and clear direct instructions. This may be in response to more challenging behaviour of their children.

Researcher-conducted home food availability inventories¹⁰⁶

For children, the home is a key environment as it serves as the primary physical and social context in which habits and norms are developed, including those specific to diet and physical activity. Home food availability/accessibility has been shown to relate to child food consumption,^{116–131} which is intuitive given that children's food intake is largely dependent on what is provided to them by others.^{124,127,132,133} The aim of this study, therefore, was to explore the home food availability of South Asian and white British participants in the BiB1000 study to describe what foods are available and to identify key differences by ethnicity or weight status.

Direct observations of food and drinks in the home were made for an opportunistic sample of 97 BiB1000 participants ($n = 46$ white British, $n = 41$ Pakistani, $n = 10$ 'other' ethnicity) using a standardised protocol.⁵¹ The inventory included counting portions of fruits (fresh, frozen, tinned, dried), vegetables (fresh, frozen, tinned), savoury snacks (crisps/tortillas, nuts), sweet snacks (cakes, biscuits, chocolate, sweets, ice cream) and beverages (sugar-sweetened drinks, diet drinks). See *Appendix 2.3* for a copy of the home food availability inventory.

Findings from this exploratory study showed that all homes had some form of fruit and some form of vegetable available in them. Overall, the presence of foods and drinks was similar in all of the ethnic groups. More homes had fresh fruits and vegetables available than canned, frozen and dried fruits and vegetables. At least one type of snack food was also available in all of the included BiB1000 homes. Of these, crisps and biscuits were most likely to be available. Descriptive analysis compared differences by ethnicity and weight. Although no differences were found for the latter, unadjusted comparisons by ethnicity showed that homes of Pakistani mothers had approximately three times the quantity of sweetened beverages available in them. Although this finding may be dependent on confounding factors (a study within the USA found that household size, presence of the maternal grandmother and shopping habits all related to home food availability¹³⁴), it does suggest that targeting these types of drinks would be useful within an intervention to prevent obesity, as these drinks offer no nutritive value.

Food outlet availability, deprivation and obesity in a multiethnic sample of pregnant women in Bradford, UK¹⁰⁷

The final environmental factor influencing obesity addressed in the current workstream was the neighbour environment in which respondents lived. The conceptualisation of an obesogenic environment has changed the way that obesity is viewed and is key to national policy documents that address obesity.¹³ The obesogenic environment operates on several levels and describes the changes in daily living, transport and access to recreational facilities, foods and food outlets that have contributed to positive energy balance and weight gain. It follows that the availability of, or people's access to, food may be related to obesity. This could be through proximity to multiple fast-food outlets or the way that people shop at large out-of-town supermarkets and stockpile food at home. However, supportive evidence is far from compelling, even though there has been increasing attention paid to the location of food outlets, especially those selling fast foods.

There is equivocal evidence for a relationship between the location of fast-food outlets and weight status^{135–143} or fast-food consumption.^{135,136,138,139,144} In contrast, the relationship between fast-food outlet density and deprivation is much clearer. Research from the UK, the USA and New Zealand has shown higher numbers of fast-food outlets in areas of high deprivation.^{145–157} However, there has been relatively little attention paid to whether or not access to, and the consumption of, fast food are affected by ethnicity, outside the USA at least, and how this is related to obesity.¹⁵⁸

This study aimed to measure access to all food outlets and to investigate the relationship with body weight, obesity and deprivation in a biethnic sample of adult women using geographic information systems (GIS) methodology. It was hypothesised that food outlet availability would be related to deprivation and that availability would be greater for South Asian participants. In addition, obese women would have greater access to food outlets, especially those selling fast foods.

Our study population came from five inner wards in the Bradford Metropolitan District, chosen because they had a range of ethnic population mix (1.2–63.8% South Asian). We included data from 1198 women within the BiB1000 cohort who lived in the study area and who provided information on age, ethnicity, height, weight at booking of pregnancy and weight at 28 weeks of pregnancy.

To map food outlet availability, we increased the study area to a total of 16 wards (five wards in which participants lived and a further 11 wards immediately bounding those areas) in recognition that individuals would not necessarily stick to the ward boundaries for local shopping and eating patterns. This search area included 819 'output areas' (OAs) (these are census geographical areas; an OA contains on average 125 households). Administrative information from the Bradford Metropolitan District Council (lists of food outlets held for health and hygiene purposes) and Bradford Yellow Pages (index of local businesses) was used to identify food outlets. A random selection of 90 OAs, stratified by deprivation, were visited to audit data collected from administrative sources.

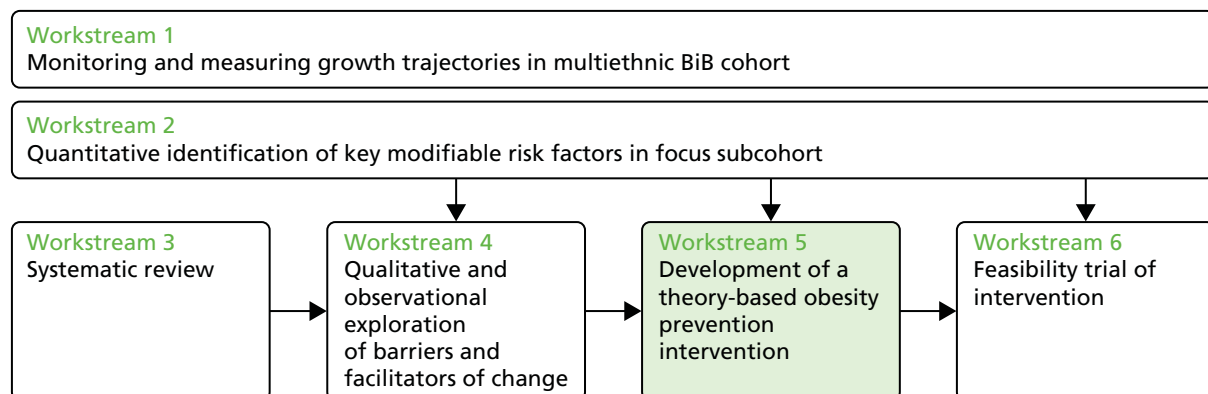
A pool of 886 outlets was identified. These outlets were classified as 'fast food' ($n = 364$), other 'eating out' (restaurants, cafes; $n = 247$), supermarkets ($n = 47$), specialist food shops (e.g. butcher, bakery; $n = 100$) and smaller retail shops selling food (e.g. convenience stores; $n = 128$). Four measures of food access were used: the distance to the nearest food outlet (proximity) in each category for each participant, the number of outlets within each food outlet category in a 250-m, 500-m and 1000-m radius of each individual's residential postcode, the number (density) of food outlets of each category in each super OA (containing four to six OAs) and proximity to clusters of three or more fast-food outlets. Univariable generalised estimating equation modelling, with obesity status as the outcome and maternal age, deprivation score and food access measure as the independent variables, was undertaken for both ethnic groups. The independent variables that were significant in the univariable analyses were combined in the multivariable analyses in a forced entry method. All statistical analyses were performed using Stata 10 (StataCorp LP, College Station, TX, USA) and statistical significance was set at $p < 0.05$.

Our results found increased food outlet availability within more deprived areas and for South Asian populations. However, the relationship between having fast-food outlet access or availability and weight status (BMI or being obese) in the South Asian group was opposite to what was hypothesised and in the non-Asian group was non-existent. This would seem to indicate that, in the current sample, increased access or availability is not related to increased consumption. Another important finding is that > 95% of participants lived within 500 m of a fast-food outlet. This degree of saturation has not been demonstrated previously but may be characteristic of UK inner cities.

This workstream aimed to explore the context and circumstances in which food choices are made. The results from these studies have the following implications for the development of a childhood obesity prevention intervention:

1. Understandings are arrived at, and choices are made, in the context of many interlinked systems of influence and these systems should be targeted in any intervention. Delivering interventions within a group setting may help to set up positive influences through peer support.
2. Intervention effectiveness will be enhanced if practitioners know which components of parenting to target within a culturally sensitive context. Parenting styles vary according to ethnicity and those practices that might constitute targets for intervention in one group would not be applicable to another, or at least would not be of equal salience.
3. Seeking to change food and drink consumption should focus on (a) promoting the availability and quantity of all types of fruits and vegetables (e.g. encouraging the purchase of tinned/frozen fruit in addition to the purchase of fresh fruit); (b) reducing the purchase of crisps and biscuits (which were both available in > 80% of homes); and (c) discouraging the purchase of sweetened beverages, especially within homes of Pakistani mothers (with 85% of these homes having at least one type of sweetened beverage available).
4. Living in close proximity to a fast-food outlet (within 500 m) was commonplace in the Bradford wards that were studied. This degree of proximity was observed in > 95% of participants. This should be considered when applications for further food outlets are made.

Using intervention mapping to develop a culturally appropriate intervention to prevent childhood obesity: development of the Healthy and Active Parenting Programme for Early Years intervention



The previous workstreams provided a wealth of epidemiological information about the risk factors for childhood obesity and the types of interpersonal, contextual and environmental factors that can influence eating behaviours. All of these are important targets for intervention. In addition, our work, including our systematic review, highlighted the importance of considering the cultural acceptability of interventions for different ethnicities and also the acceptability of interventions for low-income groups. In the current workstream we describe the development of a culturally acceptable childhood obesity prevention programme using a technique called intervention mapping.¹⁵⁹ This has been published as a separate paper.¹⁶⁰

Intervention mapping refers to a rigorous and systematic approach to developing evidence-based interventions. We followed the six key steps as follows: (1) needs assessment of parents, the wider community and practitioners and consideration of the evidence base, policy and practice; (2) identification of outcomes and change objectives following identification of barriers to behaviour change; (3) selection of theory-based methods and practical strategies to address barriers to behaviour change; (4) design of the intervention by developing evidence-based interactive activities and resources; (5) creating an adoption and implementation plan in which parenting practitioners were trained by health-care professionals to deliver the intervention within children's centres; and (6) creating an evaluation plan.

A multidisciplinary intervention development team was convened that included experts in the areas of parenting, nutrition, breastfeeding and physical activity as well as a group of experienced community health practitioners. The group met every 6–8 weeks over the course of a 12-month period to develop the intervention. The intervention was informed by behavioural change principles^{161,162} and a typology of ways of ensuring the cultural adaptation of interventions informed the development of the intervention at each stage of the process.¹⁶³

The overall desired outcome of the intervention was to prevent childhood obesity. The intervention was targeted at overweight or obese pregnant mothers. Specifically, it aimed to (1) encourage mothers to make healthy food choices antenatally and maintain a healthy diet postnatally; (2) encourage mothers to increase their level of physical activity during pregnancy and meet the recommended guidelines for physical activity (150 minutes of moderate-intensity physical activity per week¹⁶⁴) within 12 months of giving birth; (3) encourage breastfeeding (or appropriate bottle-feeding) until at least 6 months of age; (4) encourage infants to develop healthy food preferences and a healthy dietary intake; and (5) facilitate physical activity in infants and limit sedentary time.

Given that parenting skills were highlighted as an important predictor of later obesity (see *Early risk factors for childhood obesity*), it was agreed that the intervention should be developed in conjunction with an established community parenting programme: the Family Links Nurturing Programme (FLNP). The FLNP is one of the preferred parenting programmes in Bradford; its aims are to develop parents' self-esteem and self-efficacy and their understanding of their own, and their children's, emotional and physical needs. Qualitative research has demonstrated that parents value the programme and feel that it has had a positive impact on family relationships, their children's behaviour, relationship quality and their own mental health.^{165,166} This integration with the FLNP was key to ensure the sustainability of the intervention and represented a channel to ensure delivery as part of 'usual care' that could continue without the involvement of the research team. The parenting aspects of the intervention developed by the FLNP aimed to reduce the risk of child abuse and neglect, improve couple relationships, reduce stress and perinatal depression and increase prospective parents' understanding of child development. In recognition of this core component of the intervention, the intervention was designed to be delivered by facilitators trained and accredited by the FLNP [see <https://familylinks.org.uk/train-with-us> (accessed 8 March 2016) for details of the training].

The final intervention consisted of six group antenatal sessions and six group postnatal sessions and was named HAPPY (Healthy and Active Parenting Programme for early Years). It was planned that the antenatal sessions would take place weekly, starting when the mother was at 26–28 weeks' gestation. Each session lasted approximately 2.5 hours. The postnatal sessions started when the infant was aged 4–6 weeks and continued at key developmental milestones (9 weeks, 12 weeks, 5 months, 7 months and 9 months). A summary of the intervention content for the antenatal sessions and the postnatal sessions can be found in *Tables 1* and *2* respectively. Each session was detailed in a facilitator manual with step-by-step instructions on how to deliver the intervention. A 2-day training programme was developed to supplement the existing FLNP training that practitioners had already received. This included information on the background to the intervention mapping approach taken to develop the intervention; evidence-based practical education on the key messages of the intervention (nutrition, infant feeding and physical activity); time to explore the manual and practice delivering activities; and information on the importance of intervention fidelity, including how to record deviations in delivery.

The intervention mapping process, with its focus on multidisciplinary intervention development, resulted in the development of a multifaceted and evidence-based programme, capable of being integrated into existing health services within a multiethnic community in the UK. To our knowledge, this is the first childhood obesity prevention intervention of its kind with a focus on cultural appropriateness that integrates evidence based on physiological and psychosocial data collected from the local community.

The intervention mapping process was complex, time-consuming and not without challenges. These included managing competing interests from the stakeholder group and ensuring that the team understood enough about the technicalities of the process to ensure that appropriate intervention strategies were being highlighted.

TABLE 1 Key intervention content: antenatal sessions

Session	Content
1. Brain, science and bonding	<p>Parent diet: healthy diet in pregnancy; links between what you eat when pregnant, you and your baby; links between maternal and childhood obesity; reflection on own diet and importance of food in the family</p> <p>Parent physical activity: how the baby is developing in the womb and how physical activity can facilitate this</p> <p>Breastfeeding: identifying and overcoming barriers to breastfeeding</p>
2. A celebration of birth	<p>Parent diet: importance of eating well for the baby; dispel myths about weight gain in pregnancy and provide up-to-date information; Smart Snacks handout; food diaries</p> <p>Parent physical activity: being active during pregnancy; discussion regarding myths about physical activity in pregnancy</p>
3. Personal power, self-esteem and healthy choices about food	<p>Parent diet: address barriers to healthy eating and plan for ways to overcome them; signpost to cooking information points; healthy foods can be convenient and inexpensive; impact of mother eating unhealthy foods; plan alternative cooking methods</p> <p>Parent physical activity: list activities that women think they could do, work through from easy to difficult; gentle strengthening and conditioning exercises: demonstration by practitioners; worries about physical activity; visualise and positive self-talk; identify when activity can be freely integrated into normal life</p> <p>Breastfeeding: advantages/disadvantages of breastfeeding and bottle-feeding; the more you feed, the more milk is produced; encourage the identification of an influential family member, clarify likes and dislikes, talk with family members about these issues to enlist their support; learn more about breastfeeding skills; overcome stigma about breastfeeding in public, stories from other mothers</p>
4. Boundaries, beliefs and values	<p>Parent diet: additional information about snacks, food treats, swaps</p> <p>Parent physical activity: back-up plan for physical activity at different times</p> <p>Breastfeeding: values and beliefs about bringing up children and linking this to breastfeeding</p>
5. Feelings and how we communicate	<p>Parent diet: food swaps and healthy meals feedback; identify vulnerable points in time and have contingencies for when want unhealthy foods</p> <p>Parent physical activity: partners review their progress with regard to the collaborative plans made for physical activity in session 4; discussion about feelings relating to whether or not activity plans were fulfilled</p>
6. Beyond labour day	<p>Parent diet: identify someone at home/friend to discuss food habits with</p> <p>Parent physical activity: pelvic floor exercises for immediately after pregnancy if uncomplicated; what activities are OK after pregnancy</p> <p>Breastfeeding: how to make up bottle correctly; signpost to health professionals; environmental changes: clothes that facilitate feeding; locations nearby; family members can do other things with the baby (than formula feed), e.g. bottle-feed using expressed milk; infant diet: planning ahead</p>

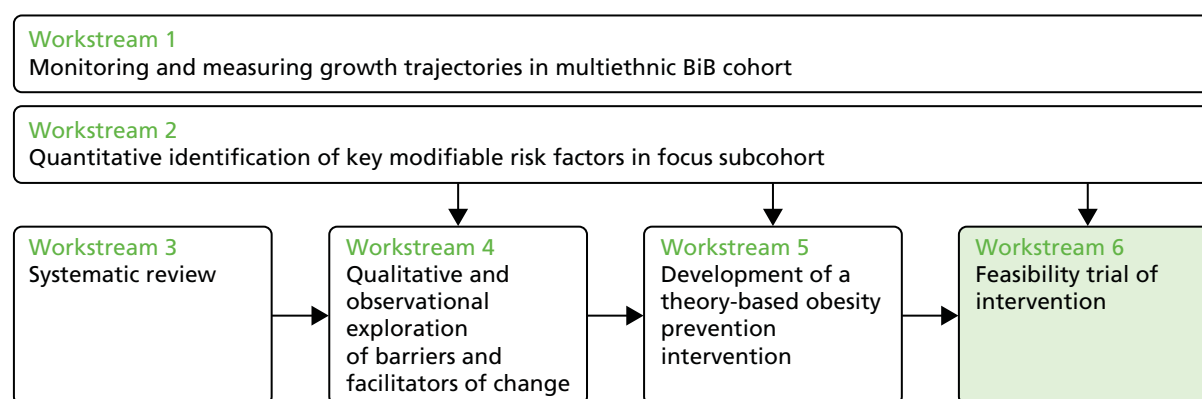
TABLE 2 Key intervention content: postnatal sessions

Session	Content
7. A celebration of birth (4 weeks)	<p>Parent diet: information about what a healthy diet should consist of; food diaries; reflect on own diet and importance of food in the family</p> <p>Parent physical activity: what activities are OK after pregnancy; gradually introduce more strenuous activity; leaflet with activity examples; physical activity for new mums quiz sheet; practitioner dispels myths</p> <p>Breastfeeding: reinforce that the more you feed, the more milk is produced; identifying someone to obtain support from; responsive feeding</p> <p>Infant physical activity: guidelines for baby activity; myths about physical activity for babies and infants; practitioner dispels myths; weekly age-appropriate activities; encourage structured and unstructured play</p>
8. Bringing structure to your life (2 months)	<p>Parent diet: healthy eating for parents vs. children; reflect on own eating patterns and provide ideas; balancing diet and avoiding takeaways</p> <p>Parent physical activity: likes/dislikes about physical activity; activities for after pregnancy; identify barriers; integrating activity into normal life; small changes to family environment; structured activities in the house; the local area; self-talk and visualisation; choose a physical activity to learn or can already do</p> <p>Breastfeeding: identifying barriers; concerns about feeding baby; how to deal with life while trying to feed; encourage asking for help to enable breastfeeding to continue and other things to be accomplished</p> <p>Infant diet: introducing solids: why and when; follow signs of readiness for weaning</p> <p>Infant physical activity: structured play activities in the house without expensive toys; introducing games; recognising when baby wants to play; being flexible with playtime; making baby-active time a priority</p>
9. Feeding and feelings (3 months)	<p>Parent physical activity: identifying and addressing barriers; coping planning; the 'Pram Pedometer Challenge'</p> <p>Infant diet: what food and drinks to give; weaning: how to do it – texture and variety, developmental stages, equipment; repeated exposure and coping with food refusal; consequences of an unhealthy diet; facial expressions and tongue thrusting</p> <p>Infant physical activity: importance of other family members engaging the baby in activity; weekly age-appropriate activities for baby and mum; making home modifications to improve child physical activity and/or eating</p>
10. Families and food (5 months)	<p>Parent diet: feeding a family – what does it take; meal planning; shopping lists; healthy foods can be convenient and inexpensive; reading food labels; impact of mother eating unhealthy foods</p> <p>Parent physical activity: review of group progress and setting goals for forthcoming weeks</p> <p>Infant diet: eating together; modelling behaviour and feeding role of family and parents; time issues with food planning and preparation</p> <p>Infant physical activity: discussion of television watching; entertaining baby/keeping baby safe when doing chores; doing activity as a family; weekly age-appropriate activities for baby and mum are demonstrated and practised; how to baby proof your house for safe physical activity</p>
11. Making the most of your day (7 months)	<p>Parent physical activity: review of group progress and setting goals for forthcoming weeks</p> <p>Infant diet: weaning: how it's going, introducing lumps</p> <p>Infant physical activity: visualisation and self-talk to build confidence; discussion of barriers and how to overcome them; planning for meal preparation, infant napping and active play; when can activity be integrated into normal life; environmental changes; weekly age-appropriate activities for baby and mum are demonstrated and practised; revisit discussion of sedentary behaviour and use of television</p>

TABLE 2 Key intervention content: postnatal sessions (*continued*)

Session	Content
12. Continuing the HAPPY journey (9 months)	<p>Parent physical activity: review of physical activity achievements; reflect on experiences; plan for physical activity in the future; include follow-up monitoring plan by practitioners; announce group winners</p> <p>Infant diet: keeping motivated to feed family well</p> <p>Infant physical activity: structured play activities in the house; involving family and friends with infant play; what local area has to offer; baby proof your house in a physical activity-friendly way; weekly age-appropriate activities; planning for after the parenting programme; joining mum and baby activity groups; signposting and goal-setting</p>

Feasibility randomised controlled trial of the Healthy and Active Parenting Programme for Early Years intervention



Having developed the HAPPY intervention, the current workstream aimed to test its feasibility and acceptability in a feasibility RCT (Phase II trial). We also aimed to provide information to inform the development of a full RCT (Phase III trial). The results of this feasibility RCT have been reported in a published article.¹⁶⁷

The specific objectives of the feasibility trial were to (1) establish the number of eligible participants in a maternity unit setting and an achievable recruitment rate; (2) establish the follow-up and attrition rates for the control and intervention groups; (3) assess the acceptability of the randomisation strategy and measurement tools; (4) determine whether or not data required for economic analysis can be collected reliably; (5) determine the primary outcome measure to estimate effect size and intraclass correlation coefficients to enable an accurate sample size calculation for a full trial; (6) assess the acceptability of the HAPPY intervention to parents and facilitators; (7) evaluate the fidelity of programme implementation and delivery by facilitators and (8) establish the capability and capacity of children's service providers to deliver and incorporate the intervention into their programme of work.

An individually randomised controlled feasibility trial with blinded assessment was conducted. Inclusion criteria were being overweight or obese (having a BMI of ≥ 25 kg/m² at the time of the pregnancy booking visit), being at least 18 years of age, able to attend intervention sessions and able to understand intervention sessions in the English language. Eligible participants were randomised to either an intervention group or a control group (usual care) in a 1 : 1 ratio stratified by maternal BMI (25–29.9 kg/m²/ ≥ 30 kg/m²), ethnicity (South Asian/other) and parity (first child/at least one other child). Participants completed questionnaires at baseline (T0, prior to randomisation, approximately 24 weeks' gestation) in their home and again when their baby was 6 months old (T1, approximately 10 months after baseline, telephone interview) and 12 months old (T2, approximately 16 months after baseline, in person). Observations, qualitative interviews and structured questionnaires with facilitators were used to explore acceptability and fidelity. The trial was approved by the Bradford Research Ethics Committee (reference number 11/YH/0458) (trial registration number ISRCTN56735429).

The recruitment rate of those screened with a BMI of ≥ 25 kg/m² was 30% (120/396). A Consolidated Standards of Reporting Trials (CONSORT) flow diagram can be found in *Figure 2*. Retention at 12 months was 66% for the intervention group and 75% for the control group. Of the 59 allocated to the intervention, 26 (44%) attended at least one antenatal appointment (attending on average 4.8 sessions) and 18 (31%)

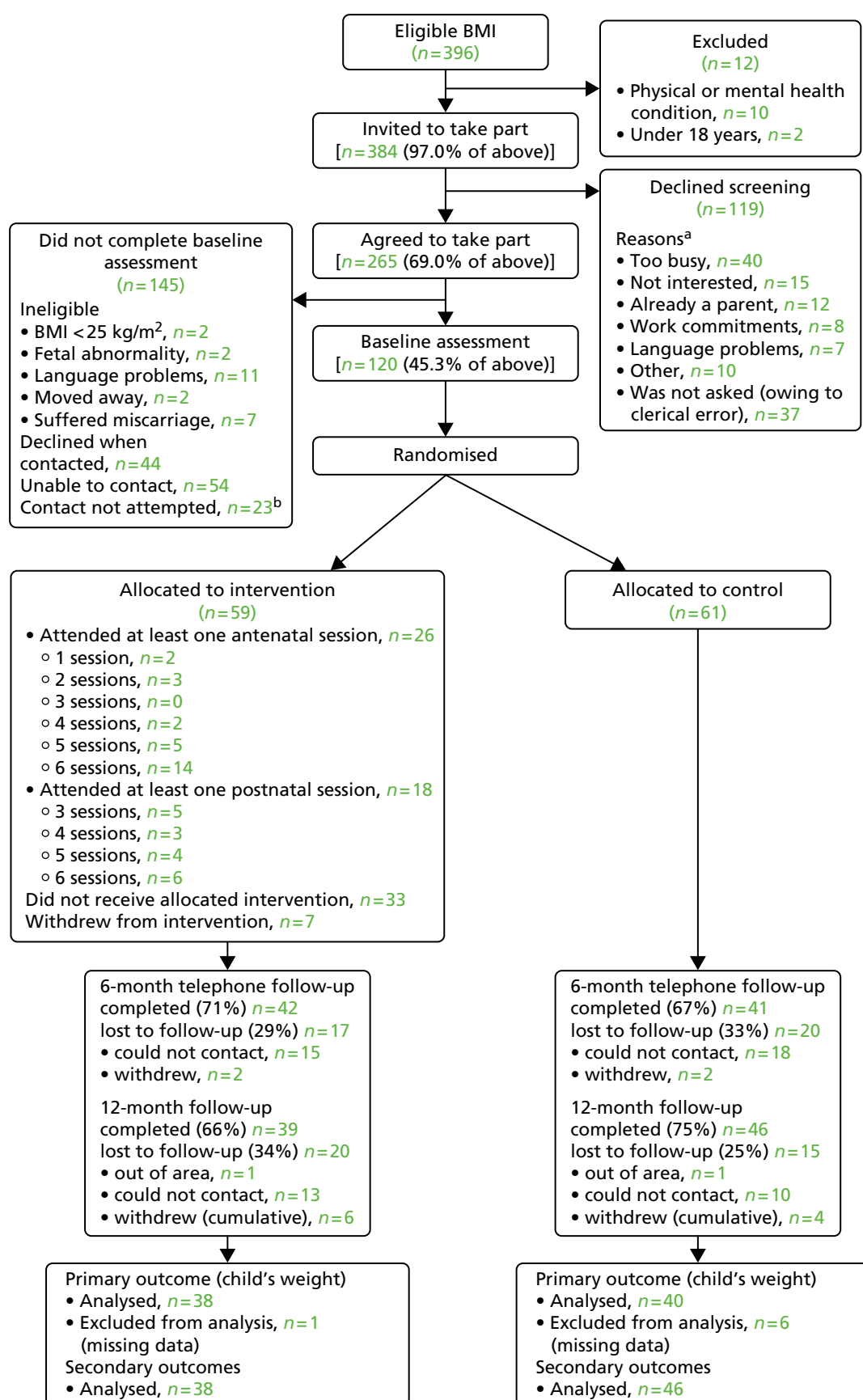


FIGURE 2 Consolidated Standards of Reporting Trials (CONSORT) flow diagram of study recruitment and retention. a, A small number of women ticked more than one reason, so totals add up to 129; b, recruitment target reached.

attended at least one postnatal session (average 4.6 sessions). Participants expressed some burden with regard to the baseline questionnaire assessment, particularly around the self-reported assessment of diet and physical activity. Responses to randomisation were mixed and there was some evidence that women were unsure of the reasons why they had been asked to take part, highlighting some problems with effective communication during the screening period. We found no problems with collecting economic data (service use and quality of life) at either the 6-month or the 12-month follow-up period.

We explored a range of appropriate possible outcome measures: age- and sex-adjusted z-score at 12 months; conditional weight gain > 1 centile band; conditional weight gain > 2 centile bands; and weight > 85th centile at 12 months. Analysis indicated that any could be considered in a future Phase III trial. The adjusted effect size using age and standardised weight z-score at 12 months was 0.25 (95% CI -0.16 to 0.66, adjusted for maternal BMI, parity and ethnicity), favouring the intervention. After discussion with a range of clinical experts, with regard to the sample size calculation, we felt that it was important in the definitive trial to take into account the ideal minimum clinically important difference (MCID) and also ensure that the follow-up period would be long enough to give confidence in the sustained impact of the intervention. We selected a MCID of 0.3 BMI SDS at 24 months as the effect size for our Phase III trial.

Participant and facilitator reaction to the intervention content was positive overall. For those in the intervention group there were no associations between attendance at intervention sessions and maternal age, gestational age, parity, booking BMI or ethnicity. Reasons for non-attendance at intervention sessions were explored with seven mothers. Some mothers (3/7) knew from the start of the project (e.g. baseline visit) that they would not be able to attend sessions because of work commitments or other concerns. Others found attendance difficult because of the timing and locations of the sessions.

Fidelity as assessed by observations of sessions and facilitator logs was high. There were some issues with certain sessions with facilitators feeling that there was too much content to cover in the time allotted, but on the whole facilitators rated delivery as straightforward/easy. Facilitators expressed some disappointment at the low numbers of women attending the sessions (ranging between two and six respondents per session).

Each intervention session was delivered by two parenting programme facilitators and required 4.5 hours of facilitator time in total (2.5 hours delivery, 1.5 hours preparation, 30 minutes contacting families). This amounted to typical staff costs of £142 per session, assuming a mix of seniority. All rooms were provided free of charge in local children's centres. Training time of 3 days per facilitator was required to allow them to deliver the intervention. One-off materials required to run the group (e.g. manuals for facilitators, reference books and DVD) cost £425 and materials for individual participants (e.g. parenting puzzle book, small gifts such as magnets, gift for child) cost £36 per participant. The total cost of staff time to deliver the training was £1163.

The feasibility trial suggests that recruitment and measurement for a definitive trial is feasible and that the HAPPY intervention is acceptable to parents and facilitators. Our experiences of recruitment are in line with those in other similar studies¹⁶⁸⁻¹⁷¹ and our process evaluation has identified valuable areas to consider to improve intervention attendance. For example, participants allocated to the intervention who engaged early (i.e. came to the first session) were likely to continue to attend future sessions. However, there was a high overall attrition rate, with many participants lost early. This was largely because the team was unable to make contact with participants (after multiple attempts to call, visit homes and search GP records). It is clear that multiple methods of contact need to be collected at baseline and then during every subsequent assessment, including contacts for extended family members, friends and neighbours. One option that we plan to explore for a definitive full trial is the possibility of obtaining e-mail addresses and social media identities, which would be validated at recruitment. In addition, qualitative data from participants also indicated that not all of those recruited fully understood the requirements of being involved in the trial. As a consequence, some were not committed to being involved.

Based on our learning and other similar trials of complex interventions, we recommend a range of strategies to maximise intervention attendance and ensure optimal group sizes for the full trial. First, it is important for research midwives to provide more information at screening and recruitment about the nature of the trial and the expectations of participants. It is hoped that this will avoid the problem of recruiting individuals who are not committed or who are not likely to participate in the intervention should they be randomised. Second, post-randomisation home visits by facilitators should be planned to meet participants and set expectations about the intervention and to encourage attendance at the first intervention session.

We found that recruitment through research nurses is feasible and this has enabled us to set realistic recruitment targets for future centres who might be involved in a full trial. Within the current feasibility study we recruited an average of 13 participants per month despite a slowing of recruitment experienced during the month of Ramadan. Given that many larger maternity units recruit to competing trials, we believe that a realistic recruitment target of around nine women per month would be feasible.

This feasibility study has a number of important lessons for the planned definitive trial. We found that recruitment and study attrition rates were in line with those in other similar trials. On the whole, measurement tools and randomisation posed no major problems for study participants, although there were some issues with the assessment of potential secondary outcomes for physical activity. Participants, facilitators and service providers found the intervention to be useful and the fidelity of implementation was high. Although there was a high dropout rate for the initial intervention session, our findings suggest that those who attended the first session were likely to continue attending.

The current findings were considered sufficiently encouraging to develop a definitive Phase III trial. A funding application is currently under way.

One of the biggest challenges of the Phase II trial was setting up intervention groups of 8–10 women who were within 6 weeks' gestation of each other and who lived in close proximity to one another. As a result, groups often did not run to capacity. This clearly impacted on costs and had an impact on the group dynamics. In response, we have changed the design so that, instead of conducting individual randomisation, clusters of 10 women will be allocated to the intervention or control together so that groups can be delivered to capacity (with individual randomisation, if it is feasible to recruit only 10 women within 6 weeks, there would not be enough to run a group after randomisation is considered). In addition, we plan to deliver the intervention in a central location with good transport links (similar to other antenatal classes) so that we do not have to wait for sufficient numbers of women to be recruited from a given postcode.

Conclusions and recommendations

Summary

This research programme has successfully achieved its principal aim of studying the patterns and aetiology of childhood obesity in a multiethnic population and has used this evidence to develop and pilot an obesity prevention intervention for early infancy. The programme completed almost all of its original objectives on time and on budget. A 9-month 'waiting period' for 1-year weight outcomes was not factored in to the original grant timetable and so has created some no-cost delay with regard to the results of the feasibility trial.

The programme has promoted strong involvement of participants and practitioners. Almost 2000 families have been recruited into the study and they have been closely followed up for 3 years. Their enthusiasm for the research and altruism they have shown in providing information and participating in activities have been a constant source of motivation for the research team. These Bradford families have donated considerable amounts of time and shared their thoughts with the research team. This has enabled us to build up a detailed picture of the pattern of their lives and the interactions that characterise their families. This is an essential requirement if we are to understand the early risk factors for obesity.

Over 300 health visitors and 100 midwives were actively involved in the routine growth measurements for the study. Their role might be best described as co-producers of this research. This commitment to collect additional data and to engage with the possibility of changing established practices reflects a deep-rooted support for health research among this group of NHS staff. Both in this research programme and in the wider collaborations centred on the BiB birth cohort study it has been apparent that this willingness to engage in research and to consider changes in practice, both to facilitate research and to implement findings, is apparent in other groups of NHS staff. The importance of having the enthusiastic support of NHS staff and the potential for change that this produces was central to the research teams obtaining a major Collaboration for Leadership in Applied Health Research and Care (CLAHRC) grant from the NIHR. This implementation award allowed us to set up communities of practice for health visitors and midwives, providing time and space for clinicians to understand and harness the rich research and routine data that we were collecting in order to improve the quality of services. As a result of this close involvement, the redesign of services was achieved and improvements in services were implemented.

We have brought together national academic experts from Bradford, Leeds, York, Bristol, Edinburgh, Loughborough, Durham and London to establish a strong multidisciplinary research network. Over the course of 5 years we have pooled our experience to develop a robust but pragmatic approach to improving the understanding, monitoring and prevention of childhood obesity. This critical mass of academic experts has provided a strong partnership for further research capacity building. This has led to synergistic grant awards totalling over £4M from the NIHR, Medical Research Council, Diabetes UK, British Heart Foundation, Child Growth Foundation, Lullaby Trust (formally the Foundation for Sudden Infant Death Syndrome; FSID) and European Union covering a range of research from biomedical science to implementation science. In addition to the HAPPY feasibility trial we were successful in obtaining NIHR funding for another pilot trial of preschool play in the playground to increase physical activity in early life. The programme has provided a research platform for five Master's students and five PhD students and has led to one Medical Research Council postdoctoral fellowship.

We are continuing to write up all of our new findings but so far > 16 papers have been accepted for peer-review publication and 36 abstracts have been published. Our Healthy Weight app is on iTunes and there is considerable interest from the children's centres involved in the feasibility trial in terms of using the HAPPY intervention. Our results on South Asian cut-off levels for BMI have informed the latest National Institute for Health and Care Excellence (NICE) guidance on assessing BMI in minority ethnic groups (NICE PH46).¹⁷² We have had strong media interest in our results with items on BBC television news and Radio 4 as well as on local radio stations and in local newspapers [see www.borninbradford.nhs.uk/the-biB-film-photography-and-poetry-gallery/ (accessed 16 March 2016)].

Conclusions from our research

The programme was successful in establishing a new childhood obesity cohort with longitudinal data collection in BiB1000. This cohort has provided a sample for the NIHR programme to develop an understanding of the predictors of and influences on health-related behaviours to help develop feasible and appropriate culturally specific intervention(s) for the prevention of childhood obesity. A unique quality of this cohort is its ethnic composition, with approximately 50% of women in the cohort being of South Asian origin, and the fact that it includes a representative sample of women from across socioeconomic groups within Bradford. Importantly, the cohort also provides a unique resource for the study of the long-term consequences of growth for childhood and later adult weight. Associations between growth and early weight and child health outcomes and educational attainment can be investigated at low cost because of the success of linkages that have been established in Bradford with primary care and education data.

There are a number of general limitations that should be considered as part of our overall conclusions. Our study was undertaken in one city and, although the results are likely to be generalisable to other large multiethnic cities in the UK, the particular white British/Pakistani composition of the BiB1000 cohort will be unique to Bradford. Prospective birth cohort studies are one of the most robust epidemiological study designs for investigating the aetiology of ill health. However, the observational nature of the design prevents any claims of causal attribution. Our qualitative studies have limitations in terms of the small sample sizes and generalisability and cannot provide quantitative predictions. Our pilot trial is by its nature preliminary and we found difficulties with recruitment and poor initial attendance.

The growth data collected as part of the BiB1000 study, supplemented with routine measurements collected by health workers in the community, provided a comprehensive and reliable data set to investigate growth in infancy and the development of obesity in childhood. For the first time in the UK we estimated weight and length growth trajectories between birth and 2 years for Pakistani boys and girls and found that they were lighter and had a shorter predicted mean length at birth than their white British counterparts, but gained weight and length more quickly in infancy. By age 2 years both ethnic groups had a similar weight but Pakistani boys and girls were taller on average than white British boys and girls. These differences in postnatal growth were not explained by maternal height, smoking during pregnancy or gestational age. We also developed data-driven prediction equations for risk of childhood obesity and incorporated them into a mobile phone app, thereby providing proof of concept that childhood obesity prediction research could be integrated with advancements in technology to deliver a clinically relevant tool to practitioners.

We found ethnic differences in breastfeeding, infant diet and sleeping patterns and in the types of physical and sedentary activities that the children engaged in. There was also evidence of dietary patterns that emerged at 12 months tracking to 18 months. Once established these patterns may become ingrained and difficult to change. There was little evidence that parenting styles differed between ethnic groups. It is important to understand ethnic differences in modifiable risk factors for childhood obesity so that interventions developed to reduce childhood obesity can be culturally adapted.

Linear and Poisson regression was used to determine the relative risk between risk factors and infant overweight. Smoking during pregnancy, maternal BMI, feeding style and parenting style were all associated with infants' BMI at age 3 years. However, the associations between these risk factors and childhood BMI did not vary by ethnicity. Interventions to reduce childhood obesity should target smoking and maternal weight in the antenatal period and postnatally encourage the adoption of warmer, less hostile parenting styles and stricter approaches to feeding.

Our systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults identified 29 studies, seven in children, 21 in adults and one in a mixed-age population. Meta-analysis of a limited number of controlled trials found an unclear picture of the effects of interventions on BMI for South Asian children. Meta-analyses of a limited number of controlled trials showed significant improvement in weight for adults but no significant differences in BMI and waist circumference. One high-quality study in South Asian children found that a school-based physical activity intervention that was delivered within the normal school day and which was culturally sensitive was effective. There was also evidence of culturally appropriate approaches to, and characteristics of, effective interventions in adults, which we believe could be transferred and used to develop effective interventions in children.

Our qualitative and observational studies exploring the influence of the family and neighbourhood settings identified a major gap in the cultural appropriateness of current measures and existing interventions for South Asian families living in the UK. Interventions need to consider how parents, in particular mothers, negotiate between the many factors that influence their behaviour, including cultural and family influences. That negotiation will be aided by interventions that support the development of self-efficacy and which offer support in how to evaluate the wide variety of advice that parents receive. Knowledge of the types and quantities of foods and drinks in family homes supports the development of intervention programmes that target an improvement in the foods available, both for obesity prevention or management and for overall diet improvement. Specifically, increasing the consumption of fruits and vegetables and reducing the consumption of sweetened drinks, crisps and biscuits should be a target. The stronger association between deprivation and fast-food density than obesity argues for more detailed accounts of the obesogenic environment that include measures of individual behaviour. The proliferation of fast-food outlets has public policy relevance and should be considered in planning applications.

Intervention mapping provided a feasible approach to developing a complex health behaviour change intervention (HAPPY). The approach was used to produce a transparent and replicable intervention whereby mechanisms of change can be investigated and identified and strategies used to manipulate them can be appropriately refined. Integration with the existing FLNP allowed the HAPPY intervention to access and utilise the expertise of existing parenting programme co-ordinators to deliver the intervention, thus increasing sustainability.

The HAPPY intervention was evaluated in a pilot RCT and was found to be feasible and acceptable. However, the recruitment rate was low and attrition between randomisation and intervention attendance was high. The full trial should address the importance of ensuring that women understand fully the nature of the research. To reduce attrition multiple methods of contact need to be collected at baseline and then during every subsequent assessment, including contacts for extended family members, friends and neighbours. A 24-month primary end point should be used to evaluate the longer-term effect of the intervention.

A proposal for a full multisite cluster RCT has incorporated these strategies and has been submitted for funding to evaluate the cost-effectiveness of the HAPPY intervention.

Recommendations for research

BiB1000: a cohort for the study of childhood obesity

- Funding should be sought to support the follow-up of this unique multiethnic child growth cohort to investigate the associations between early life exposures and later child and adult obesity.
- Data linkage to national child measurement data should be undertaken to describe growth trajectories of the children to reception year and year 6. This provides a low-cost method for capturing subsequent BMI data and an opportunity to rerun analyses of associations of modifiable risk factors with later outcomes.

Child growth

- Reliability checks including external observation of intraobserver and interobserver error should be considered to measure the accuracy of routine growth data.
- Further replication of our findings regarding ethnic differences in weight and length growth trajectories in infancy is needed.
- Research is needed that explores longer-term follow-up of these growth trajectories and examines the associations with a range of anthropometric and clinical outcomes.
- Further research is also needed to understand the genetic and environmental factors that might explain these differences.
- Further validation of the mobile phone app in other populations is needed and qualitative work is needed to understand how the mobile phone app is received by health-care practitioners.

Ethnic differences in risk factors for childhood obesity

- Despite higher rates of breastfeeding initiation and continuation to 4 months in minority ethnic groups, there is no evidence of ethnic differences in exclusive breastfeeding rates at 4 months. Therefore, interventions to increase exclusive breastfeeding rates need to target all ethnic groups.
- In light of the introduction of inappropriate foods during infancy and evidence of tracking of dietary patterns between infancy and toddler age, healthy eating advice should be offered to parents before weaning begins to maximise the possibility of establishing healthy feeding patterns.
- Obtaining data on 24-hour sleep patterns (not just night-time sleep) is vital for ethnic comparisons.
- Future research on the impact of school times on constraining sleep duration of Pakistani children and its consequences in middle childhood should be explored.
- Interventions in the early years should focus on parental behaviours and attitudes and barriers to their child's physical activity.
- Early years interventions should support parents to encourage their child's physical activity; this is likely to include playing actively with their children and taking them to places where they can be physically active.
- Further research is needed to investigate the association between early parenting and later childhood health, growth and behaviour.

Determinants of childhood obesity

- Further research is needed to investigate differences between questionnaire responses and results from direct observation of child–feeding interactions.
- More evidence on behaviour (purchase and consumption) and the use of transport for shopping is critical in developing our understanding about the role of fast-food outlets in the development of obesity.
- GIS methods should be used to investigate the association of green space exposure with physical activity and childhood obesity.

Systematic review

- We have described the types of interventions that show promise but we do not know which specific intervention components are effective. We recommend that more obesity interventions targeting South Asian populations are developed, particularly those targeting preschool children and their families. These studies should report (1) how interventions are culturally adapted; (2) the types of behaviour change techniques and theories that are used to underpin interventions; (3) anthropometric outcomes by measures of socioeconomic status; and (4) implementation and running costs. These recommendations would enable reviewers to assess how behaviour change techniques and theories moderate effectiveness, assess the equity impacts of interventions and examine explanations for heterogeneity between interventions.
- The development of effective interventions may well require a great deal of qualitative and quantitative research on knowledge, attitudes, behaviours and perceptions.
- More research is needed into the differential effects of lifestyle interventions in South Asian populations and other ethnic populations. The general approach so far has been to culturally adapt existing interventions; however, there may well be a need to develop new interventions from first principles.

Obesity intervention trial

- Further research is needed to explore how to engage overweight mothers and motivate them to attend group-based intervention sessions and how to maintain attendance over time. Intervention sessions need to be planned in advance, allowing mothers a choice of dates and enabling facilitators to book protected time to run the sessions.
- Future research should investigate the impact of different methods of recruitment (e.g. geographical vs. centralised) on intervention attendance and attrition.
- A full-scale multisite cluster RCT should be conducted to examine the effectiveness and cost-effectiveness of the intervention. This should incorporate lessons from the pilot trial about recruitment and retention and include a longer-term primary end point.
- Exploration of the best ways of translating knowledge and skills surrounding behaviour change to parenting practitioners would be beneficial to make maximum use of interactions surrounding lifestyle behaviour change. Further research is required to explore whether or not the HAPPY intervention materials can be adapted into other lower-cost means of dissemination (e.g. self-directed internet resources) and whether or not this offers an additional cost-effective means of intervention.

Acknowledgements

We are grateful to all of the families who took part in this study, the midwives for their help in recruiting them, the paediatricians and health visitors and the Born in Bradford team, which included interviewers, data managers, laboratory staff, clerical workers, research scientists, volunteers and managers.

We are particularly grateful to Pauline Raynor for her wonderful leadership and management in the recruitment of the BiB1000 cohort and to Derek Tuffnell for his clinical support. The development of the nutritional components of the HAPPY intervention owes much to the dedication and support of Jackie Loach and Judith Sargent and her team of Family Links facilitators, who were the driving force behind the successful implementation of the intervention. Ann Barratt helped to ensure that strong public engagement shaped the research from start to finish. Carolyn Clover and Lynn McVey provided indispensable administrative support.

The success of this programme is the result of the hard work and dedication of the following research staff: Dagmar Wailblinger, Sameera Ali, Kate Thompson, Samina Janjua, Sarah Ahmed, Zille Rabab, Jackie Bannister, Asma Hussain, Jo Stott, Rosalie Jozefek, Kerrie Jennings, Chrissie Bradley, Umar Toseeb, Aliyah Rizvi, Sameah Sabir, Emma Snowden, Julia Blackburn, Rihab Potrick, Syeda Ahmad, Natalie Baker and Julia Hackett.

We are grateful to completed and current PhD students who have worked on the BiB1000 study. These include Will Johnson, Jane West, Noortje Uphoff, Tom Norris, Daniel Bingham, Teumzghi Mebrahtu and Katy Shire (completed) and Hannah Roberts and Katie Marvin-Dowle (current).

Steering group members include John Wright, Carolyn Summerbell, Amanda Farrin, Diane Farrar, Emily Petherick, Gerry Richardson, Jackie Loach, Judith Sargent, Maria Bryant, Neil Small, Noel Cameron, Pinki Sahota, Raj Bhopal, Rosie McEachan, Sally E Barber and Shaheen Akhtar.

Contributions of authors

John Wright was responsible for the introduction to the report and the conclusions and recommendations.

Lesley Fairley, Emily Petherick, Gillian Santorelli, Debbie A Lawlor, Noel Cameron, Jane West and John Wright were responsible for modelling growth trajectories and obesity risk.

John Wright, Rosemary McEachan, Maria Bryant, Pinki Sahota, Gillian Santorelli, Sally Barber, Natalie Taylor, Amanda Farrin, Diane Farrar and Neil Small carried out the feasibility RCT of the HAPPY intervention.

John Wright, Maria Bryant, Gillian Santorelli and Jane West were responsible for recruitment and data collection for the BiB1000 study to investigate childhood obesity.

Lesley Fairley, Pinki Sahota, Gillian Santorelli, Sally Barber, Helen Ball and John Wright carried out the study on ethnic differences in obesity risk factors.

John Wright, Pinki Sahota and Natalie Taylor were responsible for using intervention mapping to develop a culturally appropriate intervention to prevent childhood obesity: development of the Healthy and Active Parenting Programme for Early Years intervention.

John Wright, Lesley Fairley, Maria Bryant, Emily Petherick, Pinki Sahota, Gillian Santorelli, Sally Barber, Debbie A Lawlor, Raj Bhopal, Noel Cameron, Andrew Hill, and Helen Ball carried out the study on early risk factors for childhood obesity.

Carolyn Summerbell and Tamara Brown carried out the systematic review of interventions to promote a healthy diet and physical activity in pregnant women and mothers with children under the age of 6 years with a focus on South Asian populations and low-income families.

Maria Bryant, Andrew Hill and Neil Small carried out the investigation of social and environmental determinants of childhood obesity.

Contributions of others

Will Johnson was involved in the study on modelling growth trajectories and obesity risk.

Stephanie Prady was involved in the study on ethnic differences in obesity risk factors.

Darren C Greenwood was involved in the study on early risk factors for childhood obesity.

Helen Moore, Sarah Smith, Wayne Douthwaite were involved in the systematic review of interventions to promote a healthy diet and physical activity in pregnant women and mothers with children under the age of 6 years with a focus on South Asian populations and low-income families.

Shaheen Akhtar, Sarah Wilson, Pauline Raynor, S Collins, LK Fraser, KL Edwards, M Tominitz and GP Clarke were involved in the investigation of social and environmental determinants of childhood obesity.

Shaheen Akhtar, Judith Sargent, Daniel Bingham, Sara Ahern and Gerry Richardson were involved in the feasibility RCT of the HAPPY intervention.

Publications

Recruitment and data collection for the BiB1000 cohort to investigate childhood obesity

Bryant M, Santorelli G, Raynor P, Fairley L, West J, Lawlor DA, *et al.* Born in Bradford 1000 (BIB1000): study design and cohort population characteristics. *Longit Life Course Stud* 2013;**4**:119–35.

Modelling growth trajectories and obesity risk

Johnson W, Cameron N, Dickson P, Emsley S, Raynor P, Seymour C, *et al.* The reliability of routine anthropometric data collected by health workers: a cross-sectional study. *Int J Nurs Stud* 2009;**46**:310–16. (Full-text article included in *Appendix 3*.)

Bryant M, Santorelli G, Fairley L, Petherick ES, Bhopal R, Lawlor DA, *et al.* Agreement between routine and research measurement of infant height and weight. *Arch Dis Child* 2015;**100**:24–9.

Fairley L, Petherick ES, Howe LD, Tilling K, Cameron N, Lawlor DA, *et al.* Describing differences in weight and length growth trajectories between white and Pakistani infants in the UK: analysis of the Born in Bradford birth cohort study using multilevel linear spline models. *Arch Dis Child* 2013;**98**:274–9.

Santorelli G, Petherick ES, Wright J, Wilson B, Samiei H, Cameron N, *et al.* Developing prediction equations and a mobile phone application to identify infants at risk of obesity. *PLOS ONE* 2013;**8**:e71183.

Ethnic differences in obesity risk factors

Santorelli G, Petherick ES, Waiblinger D, Fairley L. Ethnic differences in the initiation and duration of breastfeeding: evidence from the Born in Bradford cohort study. *Paediatr Perinat Epidemiol* 2013;**27**:388–92. (Full-text article included in *Appendix 3*.)

Prady SL, Kiernan K, Fairley L, Wilson S, Wright J. Self-reported maternal parenting style and confidence and infant temperament in a multi-ethnic community: results from the Born in Bradford cohort. *J Child Health Care* 2013;**18**:31–46. (Full-text article included in *Appendix 3*.)

Early risk factors for childhood obesity

Fairley L, Santorelli G, Lawlor DA, Bryant M, Bhopal R, Petherick ES, *et al.* The relationship between early life modifiable risk factors for childhood obesity, ethnicity and body mass index at age 3 years: findings from the Born in Bradford birth cohort study. *BMC Obesity* 2015;**2**:9.

Systematic review of diet and physical activity interventions to prevent or treat obesity in South Asian children and adults

Brown T, Smith S, Bhopal R, Kasim A, Summerbell C. Diet and physical activity interventions to prevent or treat obesity in South Asian children and adults: a systematic review and meta-analysis. *Int J Environ Res Health* 2015;**12**:566–94. URL: www.mdpi.com/1660-4601/12/1/566/htm#B40-ijerph-12-00566 (accessed 16 March 2016).

Investigation of social and environmental determinants of childhood obesity

Fraser LK, Edwards KL, Tominitz M, Clarke GP, Hill AJ. Food outlet availability, deprivation and obesity in a multi-ethnic sample of pregnant women in Bradford, UK. *Soc Sci Med* 2012;**75**:1048–56. (Full-text article included in *Appendix 3*.)

Bryant M, Sahota P, Santorelli G, Hill A, Wright J. An exploration and comparison of food and drink availability in homes in a sample family of white and Pakistani origin within the UK. *Public Health Nutr* 2015;**18**:1197–205. (Full-text article included in *Appendix 3*.)

Using intervention mapping to develop a culturally appropriate intervention to prevent childhood obesity: development of the Healthy and Active Parenting Programme for early Years intervention

Taylor N, Sahota P, Sargent J, Barber S, Loach J, Louch G, *et al.* Using intervention mapping to develop a culturally appropriate intervention to prevent childhood obesity: the HAPPY (Healthy and Active Parenting Programme for Early Years) study. *Int J Behav Nutr Phys Act* 2013;**10**:142.

Feasibility randomised controlled trial of the Healthy and Active Parenting Programme for early Years intervention

McEachan RRC, Santorelli G, Bryant M, Sahota P, Farrar D, Small N, *et al.* on behalf of the BiB Childhood Obesity Scientific Group. The HAPPY (Healthy and Active Parenting Programme for early Years) feasibility randomised control trial: acceptability and feasibility of an intervention to reduce infant obesity. *BMC Public Health* 2016;**16**:211. URL: <http://bmcpublihealth.biomedcentral.com/articles/10.1186/s12889-016-2861-z> (accessed 16 March 2016).

Other outputs from programme grant

Recruitment of the BiB1000 cohort to investigate childhood obesity

Journal articles

West J, Manchester B, Wright J, Lawlor DA, Waiblinger D. Reliability of routine clinical measurements of neonatal circumferences and research measurements of neonatal skinfold thicknesses: findings from the Born in Bradford study. *Paediatr Perinat Epidemiol* 2011;**25**:164–71.

Johnson W, Cameron N, Raynor P, Woffendin C, Wright J. Monitoring growth: the benefits and challenges of integrating the Born in Bradford research project with routine growth monitoring practice. *Community Practitioner* 2009;**82**:34–5.

Raynor P, Born in Bradford Collaborative Group. Born in Bradford, a cohort study of babies born in Bradford, and their parents: protocol for the recruitment phase. *BMC Public Health* 2008;**8**:327.

Bryant M, Santorelli G, Lawlor DA, Farrar D, Tuffnell D, Bhopal R, *et al.* A comparison of South Asian specific and established BMI thresholds for determining obesity prevalence in pregnancy and predicting pregnancy complications: findings from the Born in Bradford cohort. *Int J Obes (Lond)* 2013;**38**:444–50.

Conference presentations

Bryant M. Should the NHS use specific ethnic criteria to categorise South Asian women as 'obese' during pregnancy? Oral presentation. Born in Bradford: Putting Research into Practice?, Annual Conference, Bradford Royal Infirmary, Bradford, UK, 28 June 2012.

Fairley L, Small N, Bhopal R, Leon DA, Wright J, Lawlor DA. Comparison of distributions of common indicators of socioeconomic position by ethnicity and migration: preliminary findings from the Born in Bradford birth cohort study. First CHICOS workshop, Barcelona, Spain, 11–12 April 2011.

Small N. Community and user involvement in BiB. Presentation at Born in Bradford Conference, Bradford Teaching Hospitals NHS Foundation Trust, Bradford, UK, 17 June 2010.

Raynor P, Small N, Wright J. Keeping in touch. European Child Cohort Network (EUCCONET) International Workshop, Tracking Sample Members in Longitudinal Studies, London, UK, 1–2 July 2010.

Fairley L, Small N, Lawlor D, West J, Wright J. Lifestyle and socioeconomic differences of Pakistani and white UK pregnant women: the Born in Bradford birth cohort. Society for Longitudinal and Lifecourse Studies, Cambridge, UK, 22–24 September 2010.

Fairley L, Small N, Lawlor DA, Wright J. Comparison of distribution of common indicators of socioeconomic position by ethnicity and migration: preliminary findings from the Born In Bradford birth cohort study. Society for Social Medicine Conference, Belfast, UK, 1 September 2010.

Lawlor D, Fairley L, West J, Raynor P, Wright J. Lifestyle and socioeconomic differences of Pakistani and white UK pregnant women: the Born in Bradford birth cohort. Annual Meeting, 6th World Congress on Developmental Origins of Health and Disease (DOHaD), Chile, November 2009.

Small N. Born in Bradford: public involvement in a large scale, long running study. Paper presented at 6th INVOLVE National Conference, Public Involvement in Research: Getting it Right and Making a Difference, Nottingham, UK, November 2008.

Small N, Raynor P. Community consent in the Born in Bradford birth cohort study. European Child Cohort Network (EUCCONET) Workshop on Consent, INED Paris, 17–18 February 2008.

Doctoral theses

Costa S. *Measurement of Physical Activity and Sedentary Behaviour in Young Children and their Parents*. PhD thesis. Loughborough: University of Loughborough; 2013.

Modelling growth trajectories and obesity risk

Journal articles

West J, Lawlor DA, Fairley L, Bhopal R, Cameron N, McKinney PA, *et al*. UK-born Pakistani-origin infants are relatively more adipose than white British infants: findings from 8704 mother–offspring pairs in the Born-in-Bradford prospective birth cohort. *J Epidemiol Community Health* 2013;**67**:544–51.

Conference presentations

Santorelli G, Wilson B. Developing a mobile phone application to predict the risk of childhood obesity. Oral presentation. Born in Bradford: Putting Research into Practice?, Annual Conference, Bradford Royal Infirmary, Bradford, UK, 28 June 2012.

Santorelli G. Developing a mobile phone application to predict the risk of childhood obesity. Oral presentation. Childhood Obesity Pandemic: Progress, Best Practices and Frameworks for Further Action Conference, Brussels, Belgium, October 2012.

Santorelli G. Developing a mobile phone application to predict the risk of childhood obesity. Oral presentation. Management of Obesity and its Complications Conference, London, UK, October 2012.

Fairley L, Petherick ES, Howe LD, Tilling K, Cameron N, Lawlor DA, *et al*. Differences in growth trajectories between white British and Pakistani infants in the UK: analysis of the Born in Bradford birth cohort study. *Lancet* 2012;**380**:S37.

Johnson W. Modelling of longitudinal data. Human Biology Association and American Association of Physical Anthropologists Meeting, Minneapolis, MN, USA, 11–16 April 2011.

Petherick E. Use of linear spline models to describe bi-ethnic differences in early childhood growth: findings from the Born in Bradford Birth cohort study. International Epidemiological Association (IEA) World Congress of Epidemiology, Edinburgh, UK, August 2011.

Cameron N. Growth trajectories and early life development of obesity. Presentation at Born in Bradford Conference, Bradford Teaching Hospitals NHS Foundation Trust, Bradford, UK, 16 June 2011.

Johnson W. Using routine anthropometric data to characterize infant growth and investigate risk for childhood obesity. Division of Epidemiology and Community Health, School of Public Health, University of Minnesota, USA, 2010.

Johnson W. Modelling the growth of Bradford infants. Royal Statistical Society Meeting, University of Leeds, Leeds, UK, 20 September 2010.

Johnson W, Cameron N. Using routine anthropometric data to characterize infant growth. International Society for the Advancement of Kinanthropometry Conference, Estoril, Portugal, November 2010.

West J. Differences in birth size between Pakistani and white babies. Oral presentation at Born in Bradford Conference, Bradford Teaching Hospitals NHS Foundation Trust, Bradford, UK, 17 June 2010.

Cameron N. Growth in the first year. Oral presentation at Born in Bradford Conference, Bradford Teaching Hospitals NHS Foundation Trust, Bradford, UK, 17 June 2010.

Johnson W, Cameron N. The growth of Pakistani and white infants, living in Bradford, UK, in comparison to WHO standards. Symposium of the Society for the Study of Human Biology, Frascati, Italy, June 2009.

Johnson W. The growth of Bradford infants. Child Growth Foundation Annual Meeting, Northampton, UK, 2009.

Doctoral theses

Johnson W. *Born in Bradford (BiB): Examining the Birth Size and Postnatal Growth of Ethnic Minorities in Bradford*. PhD thesis. Loughborough: University of Loughborough; 2010.

West J. *Explaining Differences in Birth Size and Adiposity between Pakistani and White Babies*. PhD thesis. Leeds: University of Leeds; 2012.

Ethnic differences in obesity risk factors

Journal articles

Traviss G, West R, House A. Maternal mental health and its association with infant growth at 6 months in ethnic groups: results from the Born-in-Bradford birth cohort study. *PLOS ONE* 2012;**7**:e30707.

Conference presentations

Lawlor D. Maternal pregnancy adiposity – a determinant of postnatal offspring adiposity and cardiometabolic outcomes? Plenary lecture. Developmental Origins of Health and Disease (DOHaD) 2012 Satellite Meeting: New Developments in Developmental Epidemiology, Rotterdam, Netherlands, 6 December 2012.

Lawlor D. Developmental overnutrition: an old hypothesis with new relevance? Keynote speaker. Special seminar sponsored by the Robinson Institute, University of Adelaide, Health Development Adelaide and the School of Population Health and Clinical Practice, University of Adelaide, SA, Australia, 24 January 2012.

Sahota P, Greenwood D. Ethnic differences in diets of 12 month old infants: BIB1000 study. Keynote speaker. MRC Human Nutrition Research Unit, Cambridge University, Cambridge, UK, 6 November 2012.

Prady S. Evidence about parenting in Bradford. Oral presentation. Born in Bradford: Putting Research into Practice?, Annual Conference, Bradford Royal Infirmary, Bradford, UK, 28 June 2012.

Prady S, Fairley L, Bloor K, Gilbody S, Kiernan K, Pickett K, *et al.* Risk factors for poor mental health during pregnancy from the Born in Bradford cohort: early results from a bi-ethnic sample. International Epidemiological Association (IEA) World Congress of Epidemiology, Edinburgh, UK, August 2011.

Petherick E. Association of prenatal and postnatal smoking and alcohol on birthweight. Oral presentation at Born in Bradford Conference, Bradford Teaching Hospitals NHS Foundation Trust, Bradford, UK, 17 June 2010.

Prady S, Miles J, Fairley L, Bloor K, Gilbody S, Kiernan K, *et al.* An examination of the psychometric properties of the GHQ-28 subscales in a bi-ethnic antenatal sample in the UK: preliminary results from the Born in Bradford cohort. International Epidemiological Association (IEA) World Congress of Epidemiology, Edinburgh, UK, August 2011.

Sheridan E. Consanguinity, biraderi and associations with socio-economic position, mental health and birth weight. Oral presentation at Born in Bradford Conference, Bradford Teaching Hospitals NHS Foundation Trust, Bradford, UK, 17 June 2010.

Nieuwenhuijsen M, Smith R. Environmental exposures in pregnancy. Oral presentation at Born in Bradford Conference, Bradford Teaching Hospitals NHS Foundation Trust, Bradford, UK, 17 June 2010.

Small N. Infant mortality and migrant health in a Pakistani Muslim community in the UK. International Conference on Migration, Citizenship and Intercultural Relations, Deakin University, VIC, Australia, November 2009.

Small N. Infant mortality and morbidity in a migrant population of Pakistani origin in the UK. International Conference on Health for All: Opportunities and Challenges, International Sociological Association, Jaipur, India, September 2009.

Systematic review of interventions to promote a healthy diet and physical activity in pregnant women and mothers with children under the age of 6 years with a focus on South Asian populations and low-income families

Journal articles

Brown T, Smith S, Bhopal R, Kasim A, Summerbell C. Diet and physical activity interventions to prevent or treat obesity in South Asian children and adults: a systematic review and meta-analysis. *Int J Environ Res Public Health* 2015;**12**:566–94.

Investigation of social and environmental determinants of childhood obesity

Conference presentations

Small N, Akhtar S. Determinants of feeding practices and beliefs and attitudes about childhood obesity. Oral presentation at Born in Bradford Conference, Bradford Teaching Hospitals NHS Foundation Trust, Bradford, UK, 16 June 2011.

Doctoral theses

Mann R. *Emotional Wellbeing in Motherhood: the Validity and Acceptability of Case Finding Questions to Identify Perinatal Depression*. PhD thesis. York: University of York; 2012.

Nnadede K. *Parenting Patterns in Families of Pakistani Origin*. PhD thesis. York: University of York; 2013.

Development of an obesity prevention intervention

Conference presentations

Sahota P, Taylor N. A systematic, evidence-based and innovative approach to developing an intervention to prevent obesity. Oral presentation. Born in Bradford: Putting Research into Practice?, Annual Conference, Bradford Royal Infirmary, Bradford, UK, 28 June 2012.

McEachan R, Taylor N, Wright J, Lawton R, Raynor, P. Intervention mapping to develop two complex interventions: challenges and recommendations for future practice. Poster presentation. Population Health – Methods and Challenges, Birmingham, UK, April 2012.

Data sharing statement

Requests for data collected as part of the BiB1000 study can be made to the Born in Bradford executive group. Further information can be found here: www.borninbradford.nhs.uk/research-scientific/how-to-request-access-to-raw-bib-data/ (accessed 8 March 2016).

References

1. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes* 2006;**1**:11–25. <http://dx.doi.org/10.1080/17477160600586747>
2. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, *et al.* Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the global burden of disease study 2013. *Lancet* 2014;**384**:766–81. [http://dx.doi.org/10.1016/S0140-6736\(14\)60460-8](http://dx.doi.org/10.1016/S0140-6736(14)60460-8)
3. Rokholm B, Baker JL, Sorensen TI. The levelling off of the obesity epidemic since the year 1999 – a review of evidence and perspectives. *Obes Rev* 2010;**11**:835–46. <http://dx.doi.org/10.1111/j.1467-789X.2010.00810.x>
4. Kipping RR, Jago R, Lawlor DA. Obesity in children. Part 1: epidemiology, measurement, risk factors, and screening. *BMJ* 2008;**337**:a1824. <http://dx.doi.org/10.1136/bmj.a1824>
5. Health & Social Care Information Centre in collaboration with NatCen and UCL. *Health Survey for England 2012*. Leeds: Health and Social Care Information Centre; 2013.
6. Finucane MM, Stevens GA, Cowan MJ, Danaei G, Lin JK, Paciorek CJ, *et al.* National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet* 2011;**377**:557–67. [http://dx.doi.org/10.1016/S0140-6736\(10\)62037-5](http://dx.doi.org/10.1016/S0140-6736(10)62037-5)
7. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA* 2014;**311**:806–14. <http://dx.doi.org/10.1001/jama.2014.732>
8. Bundred P, Kitchiner D, Buchan I. Prevalence of overweight and obese children between 1989 and 1998: population based series of cross sectional studies. *BMJ* 2001;**322**:326–8. <http://dx.doi.org/10.1136/bmj.322.7282.326>
9. Kimbro RT, Brooks-Gunn J, McLanahan S. Racial and ethnic differentials in overweight and obesity among 3-year-old children. *Am J Public Health* 2007;**97**:298–305. <http://dx.doi.org/10.2105/AJPH.2005.080812>
10. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev* 2004;**5**(Suppl. 1):4–104. <http://dx.doi.org/10.1111/j.1467-789X.2004.00133.x>
11. Wright CM, Parker L, Lamont D, Craft AW. Implications of childhood obesity for adult health: findings from thousand families cohort study. *BMJ* 2001;**323**:1280–4. <http://dx.doi.org/10.1136/bmj.323.7324.1280>
12. Wang YC, McPherson K, Marsh T, Gortmaker SL, Brown M. Health and economic burden of the projected obesity trends in the USA and the UK. *Lancet* 2011;**378**:815–25. [http://dx.doi.org/10.1016/S0140-6736\(11\)60814-3](http://dx.doi.org/10.1016/S0140-6736(11)60814-3)
13. Butland B, Jebb S, Kopelman P, McPherson K, Thomas S, Mardell J, *et al.* *Foresight – Tackling Obesities: Future Choices – Project Report*, 2nd edn. London: Government Office for Science and Department of Health; 2007.
14. Dietz WH. Childhood weight affects adult morbidity and mortality. *J Nutr* 1998;**128**(Suppl. 2):411–14S.
15. Juonala M, Magnussen CG, Berenson GS, Venn A, Burns TL, Sabin MA, *et al.* Childhood adiposity, adult adiposity, and cardiovascular risk factors. *N Engl J Med* 2011;**365**:1876–85. <http://dx.doi.org/10.1056/NEJMoa1010112>

16. Pulgarón ER. Childhood obesity: a review of increased risk for physical and psychological comorbidities. *Clin Ther* 2013;**35**:A18–32. <http://dx.doi.org/10.1016/j.clinthera.2012.12.014>
17. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *Int J Obes (Lond)* 2011;**35**:891–8. <http://dx.doi.org/10.1038/ijo.2010.222>
18. Friedlander SL, Larkin EK, Rosen CL, Palermo TM, Redline S. Decreased quality of life associated with obesity in school-aged children. *Arch Pediatr Adolesc Med* 2003;**157**:1206–11. <http://dx.doi.org/10.1001/archpedi.157.12.1206>
19. Han JC, Lawlor DA, Kimm SY. Childhood obesity. *Lancet* 2010;**375**:1737–48. [http://dx.doi.org/10.1016/S0140-6736\(10\)60171-7](http://dx.doi.org/10.1016/S0140-6736(10)60171-7)
20. Nadeau KJ, Maahs DM, Daniels SR, Eckel RH. Childhood obesity and cardiovascular disease: links and prevention strategies. *Nat Rev Cardiol* 2011;**8**:513–25. <http://dx.doi.org/10.1038/nrcardio.2011.86>
21. Saxena S, Ambler G, Cole TJ, Majeed A. Ethnic group differences in overweight and obese children and young people in England: cross sectional survey. *Arch Dis Child* 2004;**89**:30–6.
22. McKeigue PM, Shah B, Marmot MG. Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. *Lancet* 1991;**337**:382–6. [http://dx.doi.org/10.1016/0140-6736\(91\)91164-P](http://dx.doi.org/10.1016/0140-6736(91)91164-P)
23. Yajnik CS, Lubree HG, Rege SS, Naik SS, Deshpande JA, Deshpande SS, et al. Adiposity and hyperinsulinemia in Indians are present at birth. *J Clin Endocrinol Metab* 2002;**87**:5575–80. <http://dx.doi.org/10.1210/jc.2002-020434>
24. Whincup PH, Gilg JA, Papacosta O, Seymour C, Miller GJ, Alberti KG, et al. Early evidence of ethnic differences in cardiovascular risk: cross sectional comparison of British South Asian and white children. *BMJ* 2002;**324**:635. <http://dx.doi.org/10.1136/bmj.324.7338.635>
25. West J, Lawlor DA, Fairley L, Bhopal R, Cameron N, McKinney PA, et al. UK-born Pakistani-origin infants are relatively more adipose than white British infants: findings from 8704 mother–offspring pairs in the Born-in-Bradford prospective birth cohort. *J Epidemiol Community Health* 2013;**67**:544–51. <http://dx.doi.org/10.1136/jech-2012-201891>
26. Jenum AK, Sommer C, Sletner L, Mørkrid K, Baerug A, Mosdøl A. Adiposity and hyperglycaemia in pregnancy and related health outcomes in European ethnic minorities of Asian and African origin: a review. *Food Nutr Res* 2013;**57**:10.3402/fnr.v57i0.18889. <http://dx.doi.org/10.3402/fnr.v57i0.18889>
27. Ravelli AC, van Der Meulen JH, Osmond C, Barker DJ, Bleker OP. Obesity at the age of 50 y in men and women exposed to famine prenatally. *Am J Clin Nutr* 1999;**70**:811–16.
28. Reilly JJ, Armstrong J, Dorosty AR, Emmett PM, Ness A, Rogers I, et al. Early life risk factors for obesity in childhood: cohort study. *BMJ* 2005;**330**:1357. <http://dx.doi.org/10.1136/bmj.38470.670903.E0>
29. Parsons TJ, Power C, Manor O. Fetal and early life growth and body mass index from birth to early adulthood in 1958 British cohort: longitudinal study. *BMJ* 2001;**323**:1331–5. <http://dx.doi.org/10.1136/bmj.323.7325.1331>
30. Singhal A, Fewtrell M, Cole TJ, Lucas A. Low nutrient intake and early growth for later insulin resistance in adolescents born preterm. *Lancet* 2003;**361**:1089–97. [http://dx.doi.org/10.1016/S0140-6736\(03\)12895-4](http://dx.doi.org/10.1016/S0140-6736(03)12895-4)
31. Lawlor DA, Chaturvedi N. Treatment and prevention of obesity – are there critical periods for intervention? *Int J Epidemiol* 2006;**35**:3–9. <http://dx.doi.org/10.1093/ije/dyi309>

32. Lawlor DA, Lichtenstein P, Langstrom N. Association of maternal diabetes mellitus in pregnancy with offspring adiposity into early adulthood: sibling study in a prospective cohort of 280,866 men from 248,293 families. *Circulation* 2011;**123**:258–65. <http://dx.doi.org/10.1161/CIRCULATIONAHA.110.980169>
33. Druet C, Stettler N, Sharp S, Simmons RK, Cooper C, Smith GD, *et al.* Prediction of childhood obesity by infancy weight gain: an individual-level meta-analysis. *Paediatr Perinat Epidemiol* 2012;**26**:19–26. <http://dx.doi.org/10.1111/j.1365-3016.2011.01213.x>
34. Baird J, Fisher D, Lucas P, Kleijnen J, Roberts H, Law C. Being big or growing fast: systematic review of size and growth in infancy and later obesity. *BMJ* 2005;**331**:929. <http://dx.doi.org/10.1136/bmj.38586.411273.E0>
35. Faith MS, Kerns J. Infant and child feeding practices and childhood overweight: the role of restriction. *Matern Child Nutr* 2005;**1**:164–8. <http://dx.doi.org/10.1111/j.1740-8709.2005.00024.x>
36. Fox MK, Reidy K, Novak T, Ziegler P. Sources of energy and nutrients in the diets of infants and toddlers. *J Am Diet Assoc* 2006;**106**(Suppl. 1):28–42. <http://dx.doi.org/10.1016/j.jada.2005.09.034>
37. Millstone E, Lobstein T, Stirling A, Mohebbati L. *Policy Options for Responding to Obesity: Cross-National Report of the PorGrow Project*. Brighton: SPRU, University of Sussex; 2006.
38. Knutson KL. Sex differences in the association between sleep and body mass index in adolescents. *J Pediatr* 2005;**147**:830–4. <http://dx.doi.org/10.1016/j.jpeds.2005.07.019>
39. Monasta L, Batty GD, Cattaneo A, Lutje V, Ronfani L, Van Lenthe FJ, *et al.* Early-life determinants of overweight and obesity: a review of systematic reviews. *Obes Rev* 2010;**11**:695–708. <http://dx.doi.org/10.1111/j.1467-789X.2010.00735.x>
40. Kramer MS, Matush L, Vanilovich I, Platt RW, Bogdanovich N, Sevkovskaya Z, *et al.* Effects of prolonged and exclusive breastfeeding on child height, weight, adiposity, and blood pressure at age 6.5 y: evidence from a large randomized trial. *Am J Clin Nutr* 2007;**86**:1717–21.
41. Oude LH, Baur L, Jansen H, Shrewsbury VA, O'Malley C, Stolk RP, *et al.* Interventions for treating obesity in children. *Cochrane Database Syst Rev* 2009;**1**:CD001872.
42. Summerbell CD, Waters E, Edmunds LD, Kelly S, Brown T, Campbell KJ. Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2005;**3**:CD001871. <http://dx.doi.org/10.1002/14651858.cd001871.pub2>
43. van Sluijs EM, McMinn AM, Griffin SJ. Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. *BMJ* 2007;**335**:703. <http://dx.doi.org/10.1136/bmj.39320.843947.BE>
44. Sharma M. International school-based interventions for preventing obesity in children. *Obes Rev* 2007;**8**:155–67. <http://dx.doi.org/10.1111/j.1467-789X.2006.00268.x>
45. Brown T, Kelly S, Summerbell C. Prevention of obesity: a review of interventions. *Obes Rev* 2007;**8**(Suppl. 1):127–30. <http://dx.doi.org/10.1111/j.1467-789X.2007.00331.x>
46. Campbell KJ, Hesketh KD. Strategies which aim to positively impact on weight, physical activity, diet and sedentary behaviours in children from zero to five years. A systematic review of the literature. *Obes Rev* 2007;**8**:327–38. <http://dx.doi.org/10.1111/j.1467-789X.2006.00305.x>
47. Waters E, de Silva-Sanigorski A, Hall BJ, Brown T, Campbell KJ, Gao Y, *et al.* Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2011;**12**:CD001871. <http://dx.doi.org/10.1002/14651858.cd001871.pub3>
48. Bleich SN, Segal J, Wu Y, Wilson R, Wang Y. Systematic review of community-based childhood obesity prevention studies. *Pediatrics* 2013;**132**:e201–10. <http://dx.doi.org/10.1542/peds.2013-0886>

49. Hillier F, Pedley C, Summerbell C. Evidence base for primary prevention of obesity in children and adolescents. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2011;**54**:259–64. <http://dx.doi.org/10.1007/s00103-010-1227-4>
50. Barker DJ. Obesity and early life. *Obes Rev* 2007;**8**(Suppl. 1):45–9. <http://dx.doi.org/10.1111/j.1467-789X.2007.00317.x>
51. van der Horst K, Oenema A, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F, et al. A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Educ Res* 2007;**22**:203–26. <http://dx.doi.org/10.1093/her/cyl069>
52. Northstone K, Rogers I, Emmett P, ALSPAC Team Study, Avon Longitudinal Study of Pregnancy and Childhood. Drinks consumed by 18-month-old children: are current recommendations being followed? *Eur J Clin Nutr* 2002;**56**:236–44. P <http://dx.doi.org/10.1038/sj.ejcn.1601313>
53. Reilly JJ, Jackson DM, Montgomery C, Kelly LA, Slater C, Grant S, et al. Total energy expenditure and physical activity in young Scottish children: mixed longitudinal study. *Lancet* 2004;**363**:211–12. [http://dx.doi.org/10.1016/S0140-6736\(03\)15331-7](http://dx.doi.org/10.1016/S0140-6736(03)15331-7)
54. Etelson D, Brand DA, Patrick PA, Shirali A. Childhood obesity: do parents recognize this health risk? *Obes Res* 2003;**11**:1362–8. <http://dx.doi.org/10.1038/oby.2003.184>
55. Ong KK, Loos RJ. Rapid infancy weight gain and subsequent obesity: systematic reviews and hopeful suggestions. *Acta Paediatr* 2006;**95**:904–8. <http://dx.doi.org/10.1080/08035250600719754>
56. Morandi A, Meyre D, Lobbens S, Kleinman K, Kaakinen M, Rifas-Shiman SL, et al. Estimation of newborn risk for child or adolescent obesity: lessons from longitudinal birth cohorts. *PLOS ONE* 2012;**7**:e49919. <http://dx.doi.org/10.1371/journal.pone.0049919>
57. Flynn MA, McNeil DA, Maloff B, Mutasingwa D, Wu M, Ford C, et al. Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations. *Obes Rev* 2006;**7**(Suppl. 1):7–66. <http://dx.doi.org/10.1111/j.1467-789X.2006.00242.x>
58. Hesketh KD, Campbell KJ. Interventions to prevent obesity in 0–5 year olds: an updated systematic review of the literature. *Obesity (Silver Spring)* 2010;**18**(Suppl. 1):S27–35. <http://dx.doi.org/10.1038/oby.2009.429>
59. Pocock M, Trivedi D, Willis W, Bunn F, Magnusson J. Parental perceptions regarding healthy behaviours for preventing overweight and obesity in young children: a systematic review of qualitative studies. *Obes Rev* 2010;**11**:338–53. <http://dx.doi.org/10.1111/j.1467-789X.2009.00648.x>
60. Ward DS, Vaughn AE, Bangdiwala KI, Campbell M, Jones DJ, Panter AT, et al. Integrating a family-focused approach into child obesity prevention: rationale and design for the My Parenting SOS study randomized control trial. *BMC Public Health* 2011;**11**:431. <http://dx.doi.org/10.1186/1471-2458-11-431>
61. Harvey-Berino J, Rourke J. Obesity prevention in preschool native-american children: a pilot study using home visiting. *Obes Res* 2003;**11**:606–11. <http://dx.doi.org/10.1038/oby.2003.87>
62. Wright J, Small N, Raynor P, Tuffnell D, Bhopal R, Cameron N, et al. Cohort profile: the Born in Bradford multi-ethnic family cohort study. *Int J Epidemiol* 2013;**42**:978–91. <http://dx.doi.org/10.1093/ije/dys112>
63. Bryant M, Santorelli G, Fairley L, West J, Lawlor DA, Bhopal R, et al. Design and characteristics of a new birth cohort, beginning in pregnancy, to study the early origins and ethnic variation of childhood obesity: the BiB1000 study. *Longit Life Course Stud* 2013;**4**(2).
64. Cole TJ, Freeman JV, Preece MA. Body mass index reference curves for the UK, 1990. *Arch Dis Child* 1995;**73**:25–9.

65. National Centre for Social Research and University College London. *Millenium Cohort First Study: CAPI Questionnaire Documentation*. London: University College London; 2003.
66. Australian Institute of Family Studies. *Growing up in Australia: the Longitudinal Study of Australian Children: Wave 1*. LSAC Discussion Paper No. 2; 2003. URL: www.aifs.gov.au/growingup/pubs/discussion/dp2/index.html (accessed February 2012).
67. Office for National Statistics. *Census 2001: General Report for England and Wales*. London: ONS; 2005.
68. Riboli E, Hunt K, Slimani N, Ferrari P, Norat T, Fahey M, et al. European Prospective Investigation into Cancer and Nutrition (EPIC): study populations and data collection. *Public Health Nutr* 2002;**5**:1113–24. <http://dx.doi.org/10.1079/PHN2002394>
69. Cameron N, Demerath E. Critical periods in human growth: relationships to chronic disease. *Yearb Phys Anthropol* 2002;**45**:159–84. <http://dx.doi.org/10.1002/ajpa.10183>
70. Johnson W, Cameron N, Dickson P, Emsley S, Raynor P, Seymour C, et al. The reliability of routine anthropometric data collected by health workers: a cross-sectional study. *Int J Nurs Stud* 2009;**46**:310–16.
71. Bryant M, Santorelli G, Fairley L, Petherick ES, Bhopal R, Lawlor DA, et al. Agreement between routine and research measurement of infant height and weight. *Arch Dis Child* 2015;**100**:24–29.
72. Fairley L, Petherick ES, Howe LD, Tilling K, Cameron N, Lawlor DA, et al. Describing differences in weight and length growth trajectories between white and Pakistani infants in the UK: analysis of the Born in Bradford birth cohort study using multilevel linear spline models. *Arch Dis Child* 2013;**98**:274–9.
73. Santorelli G, Petherick ES, Wright J, Wilson B, Samiei H, Cameron N, et al. Developing prediction equations and a mobile phone application to identify infants at risk of obesity. *PLOS ONE* 2013;**8**:e71183.
74. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: consequences for adult health and human capital. *Lancet* 2008;**371**:340–57. [http://dx.doi.org/10.1016/S0140-6736\(07\)61692-4](http://dx.doi.org/10.1016/S0140-6736(07)61692-4)
75. Singhal A, Lucas A. Early origins of cardiovascular disease: is there a unifying hypothesis? *Lancet* 2004;**363**:1642–5. [http://dx.doi.org/10.1016/S0140-6736\(04\)16210-7](http://dx.doi.org/10.1016/S0140-6736(04)16210-7)
76. Department of Health. *Health Survey for England 1999: the Health of Minority Ethnic Groups*. London: Department of Health; 2001.
77. Barnett AH, Dixon AN, Bellary S, Hanif MW, O'Hare JP, Raymond NT, et al. Type 2 diabetes and cardiovascular risk in the UK south Asian community. *Diabetologia* 2006;**49**:2234–46. <http://dx.doi.org/10.1007/s00125-006-0325-1>
78. Balarajan R. Ethnicity and variations in mortality from coronary heart disease. *Health Trends* 1996;**28**:45–51.
79. Whincup PH, Nightingale CM, Owen CG, Rudnicka AR, Gibb I, McKay CM, et al. Early emergence of ethnic differences in type 2 diabetes precursors in the UK: the Child Heart and Health Study in England (CHASE study). *PLOS Med* 2010;**7**:e1000263. <http://dx.doi.org/10.1371/journal.pmed.1000263>
80. Ehtisham S, Crabtree N, Clark P, Shaw N, Barrett T. Ethnic differences in insulin resistance and body composition in United Kingdom adolescents. *J Clin Endocrinol Metab* 2005;**90**:3963–9. <http://dx.doi.org/10.1210/jc.2004-2001>
81. Department of Health. *Healthy Weight, Healthy Lives: a Cross-Government Strategy for England*. London: Department of Health; 2008.

82. Santorelli G, Petherick ES, Waiblinger D, Fairley L. Ethnic differences in the initiation and duration of breastfeeding: evidence from the Born in Bradford cohort study. *Paediatr Perinat Epidemiol* 2013;**27**:388–392.
83. Prady SL, Kiernan K, Fairley L, Wilson S, Wright J. Self-reported maternal parenting style and confidence and infant temperament in a multi-ethnic community: results from the Born in Bradford cohort. *J Child Health Care* 2013;**18**:31–46.
84. Griffiths LJ, Tate AR, Dezateux C. The contribution of parental and community ethnicity to breastfeeding practices: evidence from the Millennium Cohort Study. *Int J Epidemiol* 2005;**34**:1378–86. <http://dx.doi.org/10.1093/ije/dyi162>
85. Hawkins SS, Lamb K, Cole TJ, Law C, Millennium Cohort Study Child Health Group. Influence of moving to the UK on maternal health behaviours: prospective cohort study. *BMJ* 2008;**336**:1052–5. <http://dx.doi.org/10.1136/bmj.39532.688877.25>
86. Department of Health. *Physical Activity, Health Improvement and Protection. Start Active, Stay Active: Report on Physical Activity from the Four Home Countries' Chief Medical Officers*. London: Department of Health; 2011.
87. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sport Exerc* 2000;**32**:963–75. <http://dx.doi.org/10.1097/00005768-200005000-00014>
88. Ferreira I, van der Horst K, Wendel-Vos W, Kremers S, van Lenthe FJ, Brug J. Environmental correlates of physical activity in youth – a review and update. *Obes Rev* 2007;**8**:129–54. <http://dx.doi.org/10.1111/j.1467-789X.2006.00264.x>
89. Cleland V, Crawford D, Baur LA, Hume C, Timperio A, Salmon J. A prospective examination of children's time spent outdoors, objectively measured physical activity and overweight. *Int J Obes (Lond)* 2008;**32**:1685–93. <http://dx.doi.org/10.1038/ijo.2008.171>
90. Cooper AR, Page AS, Wheeler BW, Hillsdon M, Griew P, Jago R. Patterns of GPS measured time outdoors after school and objective physical activity in English children: the PEACH project. *Int J Behav Nutr Phys Act* 2010;**7**:31. <http://dx.doi.org/10.1186/1479-5868-7-31>
91. Owen CG, Nightingale CM, Rudnicka AR, Cook DG, Ekelund U, Whincup PH. Ethnic and gender differences in physical activity levels among 9–10-year-old children of white European, South Asian and African-Caribbean origin: the Child Heart Health Study in England (CHASE study). *Int J Epidemiol* 2009;**38**:1082–93. <http://dx.doi.org/10.1093/ije/dyp176>
92. Fairley L, Santorelli G, Lawlor DA, Bryant M, Bhopal R, Petherick ES, *et al*. The relationship between early life modifiable risk factors for childhood obesity, ethnicity and body mass index at age 3 years: findings from the Born in Bradford birth cohort study. *BMC Obesity* 2015;**2**:9.
93. Weng SF, Redsell SA, Swift JA, Yang M, Glazebrook CP. Systematic review and meta-analyses of risk factors for childhood overweight identifiable during infancy. *Arch Dis Child* 2012;**97**:1019–26. <http://dx.doi.org/10.1136/archdischild-2012-302263>
94. Oken E, Levitan EB, Gillman MW. Maternal smoking during pregnancy and child overweight: systematic review and meta-analysis. *Int J Obes (Lond)* 2008;**32**:201–10. <http://dx.doi.org/10.1038/sj.ijo.0803760>
95. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *N Engl J Med* 1997;**337**:869–73. <http://dx.doi.org/10.1056/NEJM199709253371301>
96. Hurley KM, Cross MB, Hughes SO. A systematic review of responsive feeding and child obesity in high-income countries. *J Nutr* 2011;**141**:495–501. <http://dx.doi.org/10.3945/jn.110.130047>

97. Hughes SO, Power TG, Orlet Fisher J, Mueller S, Nicklas TA. Revisiting a neglected construct: parenting styles in a child-feeding context. *Appetite* 2005;**44**:83–92. <http://dx.doi.org/10.1016/j.appet.2004.08.007>
98. Sleddens EF, Gerards SM, Thijs C, de Vries NK, Kremers SP. General parenting, childhood overweight and obesity-inducing behaviors: a review. *Int J Pediatr Obes* 2011;**6**:e12–27. <http://dx.doi.org/10.3109/17477166.2011.566339>
99. Campbell K, Hesketh K, Silverii A, Abbott G. Maternal self-efficacy regarding children's eating and sedentary behaviours in the early years: associations with children's food intake and sedentary behaviours. *Int J Pediatr Obes* 2010;**5**:501–8. <http://dx.doi.org/10.3109/17477161003777425>
100. Pearce J, Langley-Evans SC. The types of food introduced during complementary feeding and risk of childhood obesity: a systematic review. *Int J Obes (Lond)* 2013;**37**:477–85. <http://dx.doi.org/10.1038/ijo.2013.8>
101. Chen X, Beydoun MA, Wang Y. Is sleep duration associated with childhood obesity? A systematic review and meta-analysis. *Obesity (Silver Spring)* 2008;**16**:265–74. <http://dx.doi.org/10.1038/oby.2007.63>
102. Liu J, Zhang A, Li L. Sleep duration and overweight/obesity in children: review and implications for pediatric nursing. *J Spec Pediatr Nurs* 2012;**17**:193–204. <http://dx.doi.org/10.1111/j.1744-6155.2012.00332.x>
103. Philipps LH, Santhakumaran S, Gale C, Prior E, Logan KM, Hyde MJ, *et al.* The diabetic pregnancy and offspring BMI in childhood: a systematic review and meta-analysis. *Diabetologia* 2011;**54**:1957–66. <http://dx.doi.org/10.1007/s00125-011-2180-y>
104. Kim SY, England JL, Sharma JA, Njoroge T. Gestational diabetes mellitus and risk of childhood overweight and obesity in offspring: a systematic review. *Exp Diabetes Res* 2011;**2011**:541308. <http://dx.doi.org/10.1155/2011/541308>
105. Brown T, Smith S, Bhopal R, Kasim A, Summerbell C. Diet and physical activity interventions to prevent or treat obesity in South Asian children and adults: a systematic review and meta-analysis. *Int J Environ Res Public Health* 2015;**12**:566–94. <http://dx.doi.org/10.3390/ijerph120100566>
106. Bryant M, Sahota P, Santorelli G, Hill A. An exploration and comparison of food and drink availability in homes in a sample of families of white and Pakistani origin within the UK. *Public Health Nutr* 2015;**18**:1197–205. <http://dx.doi.org/10.1017/S1368980014000147>
107. Fraser LK, Edwards KL, Tominitz M, Clarke GP, Hill AJ. Food outlet availability, deprivation and obesity in a multi-ethnic sample of pregnant women in Bradford, UK. *Soc Sci Med* 2012;**75**:1048–56. <http://dx.doi.org/10.1016/j.socscimed.2012.04.041>
108. Riessman CK. *Narrative Analysis*. London: Sage; 1993.
109. Baumrind D. Current patterns of parental authority. *Dev Psychol Monogr* 1971;**4**:1–103. <http://dx.doi.org/10.1037/h0030372>
110. Maccoby EE, Martin JA. Socialization in the Context of the Family: Parent–Child Interaction. In Hetherington EM, editor. *Handbook of Child Psychology: Socialization, Personality, and Social Development*, 4th edn. New York, NY: Wiley; 1983. pp. 1–101.
111. Blisset J. Relationships between parenting style, feeding style and feeding practices and fruit and vegetable consumption in early childhood. *Appetite* 2011;**57**:826. <http://dx.doi.org/10.1016/j.appet.2011.05.318>
112. Van Campen KS, Russell ST. *Cultural Differences in Parenting Practices: What Asian American Families Can Teach Us (Vol. 2, No. 1)*. Tucson, AZ: Frances McClelland Institute for Children, Youth, and Families Research Link, University of Arizona; 2010.

113. Wilson SL. *A Mealtime Observation Study: Obesity, Ethnicity and Observed Maternal Feeding Styles*. D Clin Psychol thesis. Leeds: University of Leeds; 2011. URL: http://etheses.whiterose.ac.uk/1739/1/Mealtime_Observation_Study_22nd_Sept_2011.pdf (accessed 2 February 2016).
114. Cullen KW, Baranowski T, Rittenberry L, Cosart C, Hebert D, de Moor C. Child-reported family and peer influences on fruit, juice and vegetable consumption: reliability and validity of measures. *Health Educ Res* 2001;**16**:187–200. <http://dx.doi.org/10.1093/her/16.2.187>
115. Downs SM, Arnold A, Marshall D, McCargar LJ, Raine KD, Willows ND. Associations among the food environment, diet quality and weight status in Cree children in Quebec. *Public Health Nutr* 2009;**12**:1504–11. <http://dx.doi.org/10.1017/S1368980008004515>
116. Gable S, Lutz S. Household, parent, and child contributions to childhood obesity. *Fam Relat* 2000;**49**:293–300. <http://dx.doi.org/10.1111/j.1741-3729.2000.00293.x>
117. Gattshall ML, Shoup JA, Marshall JA, Crane LA, Estabrooks PA. Validation of a survey instrument to assess home environments for physical activity and healthy eating in overweight children. *Int J Behav Nutr Phys Act* 2008;**5**:3. <http://dx.doi.org/10.1186/1479-5868-5-3>
118. Hanson NI, Neumark-Sztainer D, Eisenberg ME, Story M, Wall M. Associations between parental report of the home food environment and adolescent intakes of fruits, vegetables and dairy foods. *Public Health Nutr* 2005;**8**:77–85. <http://dx.doi.org/10.1079/PHN2005661>
119. Hearn MD, Baranowski T, Baranowski J, Doyle C, Smith M, Lin L, et al. Environmental influences on dietary behavior among children: availability and accessibility of fruits and vegetables enable consumption. *J Health Educ* 1998;**29**:26–32. <http://dx.doi.org/10.1080/10556699.1998.10603294>
120. Kratt P, Reynolds K, Shewchuk R. The role of availability as a moderator of family fruit and vegetable consumption. *Health Educ Behav* 2000;**27**:471–82. <http://dx.doi.org/10.1177/109019810002700409>
121. Neumark-Sztainer D, Wall M, Perry C, Story M. Correlates of fruit and vegetable intake among adolescents. Findings from Project EAT. *Prev Med* 2003;**37**:198–208. [http://dx.doi.org/10.1016/S0091-7435\(03\)00114-2](http://dx.doi.org/10.1016/S0091-7435(03)00114-2)
122. Patterson RE, Kristal AR, Shannon J, Hunt JR, White E. Using a brief household food inventory as an environmental indicator of individual dietary practices. *Am J Public Health* 1997;**87**:272–5. <http://dx.doi.org/10.2105/AJPH.87.2.272>
123. Pearson N, Biddle SJ, Gorely T. Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. *Public Health Nutr* 2009;**12**:267–83. <http://dx.doi.org/10.1017/S1368980008002589>
124. Raynor HA, Polley BA, Wing RR, Jeffery RW. Is dietary fat intake related to liking or household availability of high- and low-fat foods? *Obes Res* 2004;**12**:816–23. <http://dx.doi.org/10.1038/oby.2004.98>
125. Reynolds KD, Hinton AW, Shewchuk R, Hickey CA. Social cognitive model of fruit and vegetable consumption in elementary school children. *J Nutr Educ* 1999;**31**:23–30. [http://dx.doi.org/10.1016/S0022-3182\(99\)70381-X](http://dx.doi.org/10.1016/S0022-3182(99)70381-X)
126. Spurrier NJ, Magarey AA, Golley R, Curnow F, Sawyer MG. Relationships between the home environment and physical activity and dietary patterns of preschool children: a cross-sectional study. *Int J Behav Nutr Phys Act* 2008;**5**:31. <http://dx.doi.org/10.1186/1479-5868-5-31>
127. Baranowski T, Domel S, Gould R, Baranowski J, Leonard S, Treiber F, et al. Increasing fruit and vegetable consumption among 4th and 5th grade students – results from focus groups using reciprocal determinism. *J Nutr Educ* 1993;**25**:114–20. [http://dx.doi.org/10.1016/S0022-3182\(12\)80567-X](http://dx.doi.org/10.1016/S0022-3182(12)80567-X)

128. Story M, Kaphingst KM, Robinson-O'Brien R, Glanz K. Creating healthy food and eating environments: policy and environmental approaches. *Ann Rev Public Health* 2008;**29**:253–72. <http://dx.doi.org/10.1146/annurev.publhealth.29.020907.090926>
129. Stevens J, Bryant M, Wang CH, Cai J, Bentley ME. Sample size and repeated measures required in studies of foods in the homes of African-American families. *J Nutr* 2012;**142**:1123–7. <http://dx.doi.org/10.3945/jn.111.150060>
130. Byrd-Bredbenner C, Abbot JM. Differences in food supplies of US households with and without overweight individuals. *Appetite* 2009;**52**:479–84. <http://dx.doi.org/10.1016/j.appet.2008.12.011>
131. Schefske SD, Bellows AC, Byrd-Bredbenner C, Cuite CL, Rapport H, Vivar T, *et al.* Nutrient analysis of varying socioeconomic status home food environments in New Jersey. *Appetite* 2010;**54**:384–9. <http://dx.doi.org/10.1016/j.appet.2010.01.007>
132. Fulkerson JA, Nelson MC, Lytle L, Moe S, Heitzler C, Pasch KE. The validation of a home food inventory. *Int J Behav Nutr Phys Act* 2008;**5**:55. <http://dx.doi.org/10.1186/1479-5868-5-55>
133. Schefske SD, Byrd-Bredbenner C, Cuite CL, Hallman WK. *Using UPC Scanning Methods to Characterize Household Food Supplies of Multi-Ethnic Low Income Minorities*. 2010;**110**:A103.
134. Stevens J, Bryant M, Wang L, Borja J, Bentley ME. Exhaustive measurement of food items in the home using a universal product code scanner. *Public Health Nutr* 2011;**14**:314–18. <http://dx.doi.org/10.1017/S1368980010001837>
135. Davis B, Carpenter C. Proximity of fast-food restaurants to schools and adolescent obesity. *Am J Public Health* 2009;**99**:505–10. <http://dx.doi.org/10.2105/AJPH.2008.137638>
136. Jeffery RW, Baxter J, McGuire M, Linde J. Are fast food restaurants an environmental risk factor for obesity? *Int J Behav Nutr Phys Act* 2006;**3**:2. <http://dx.doi.org/10.1186/1479-5868-3-2>
137. Mehta NK, Chang VW. Weight status and restaurant availability: a multilevel analysis. *Am J Prev Med* 2008;**34**:127–33. <http://dx.doi.org/10.1016/j.amepre.2007.09.031>
138. Morland KB, Evenson KR. Obesity prevalence and the local food environment. *Health Place* 2009;**15**:491–5. <http://dx.doi.org/10.1016/j.healthplace.2008.09.004>
139. Pearce J, Hiscock R, Blakely T, Witten K. A national study of the association between neighbourhood access to fast-food outlets and the diet and weight of local residents. *Health Place* 2009;**15**:193–7. <http://dx.doi.org/10.1016/j.healthplace.2008.04.003>
140. Burdette HL, Whitaker RC. Neighborhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. *Prev Med* 2004;**38**:57–63. <http://dx.doi.org/10.1016/j.ypmed.2003.09.029>
141. Casey AA, Elliott M, Glanz K, Haire-Joshu D, Lovegreen SL, Saelens BE, *et al.* Impact of the food environment and physical activity environment on behaviors and weight status in rural US communities. *Prev Med* 2008;**47**:600–4. <http://dx.doi.org/10.1016/j.ypmed.2008.10.001>
142. Rundle A, Neckerman KM, Freeman L, Lovasi GS, Purciel M, Quinn J, *et al.* Neighborhood food environment and walkability predict obesity in New York City. *Environ Health Perspect* 2009;**117**:442–7. <http://dx.doi.org/10.1289/ehp.11590>
143. Wang MC, Cubbin C, Ahn D, Winkleby MA. Changes in neighbourhood food store environment, food behaviour and body mass index, 1981–1990. *Public Health Nutr* 2008;**11**:963–70. <http://dx.doi.org/10.1017/S136898000700105X>
144. Simmons D, McKenzie A, Eaton S, Cox N, Khan MA, Shaw J, *et al.* Choice and availability of takeaway and restaurant food is not related to the prevalence of adult obesity in rural communities in Australia. *Int J Obes (Lond)* 2005;**29**:703–10. <http://dx.doi.org/10.1038/sj.ijo.0802941>

145. Block JP, Scribner RA, DeSalvo KB. Fast food, race/ethnicity, and income: a geographic analysis. *Am J Prev Med* 2004;**27**:211–17. <http://dx.doi.org/10.1016/j.amepre.2004.06.007>
146. Burns CM, Inglis AD. Measuring food access in Melbourne: access to healthy and fast foods by car, bus and foot in an urban municipality in Melbourne. *Health Place* 2007;**13**:877–85. <http://dx.doi.org/10.1016/j.healthplace.2007.02.005>
147. Cummins SC, McKay L, MacIntyre S. McDonald's restaurants and neighborhood deprivation in Scotland and England. *Am J Prev Med* 2005;**29**:308–10. <http://dx.doi.org/10.1016/j.amepre.2005.06.011>
148. Fraser LK, Edwards KL. The association between the geography of fast food outlets and childhood obesity rates in Leeds, UK. *Health Place* 2010;**16**:1124–8. <http://dx.doi.org/10.1016/j.healthplace.2010.07.003>
149. Lewis LB, Sloane DC, Nascimento LM, Diamant AL, Guinyard JJ, Yancey AK, et al. African Americans' access to healthy food options in South Los Angeles restaurants. *Am J Public Health* 2005;**95**:668–73. <http://dx.doi.org/10.2105/AJPH.2004.050260>
150. Macdonald L, Cummins S, Macintyre S. Neighbourhood fast food environment and area deprivation – substitution or concentration? *Appetite* 2007;**49**:251e4.
151. Morland K, Wing S, Diez Roux A, Poole C. Neighborhood characteristics associated with the location of food stores and food service places. *Am J Prev Med* 2002;**22**:23–9. [http://dx.doi.org/10.1016/S0749-3797\(01\)00403-2](http://dx.doi.org/10.1016/S0749-3797(01)00403-2)
152. Pearce J, Blakely T, Witten K, Bartie P. Neighborhood deprivation and access to fast-food retailing: a national study. *Am J Prev Med* 2007;**32**:375–82. <http://dx.doi.org/10.1016/j.amepre.2007.01.009>
153. Powell LM, Chaloupka FJ, Bao Y. The availability of fast-food and full-service restaurants in the United States: associations with neighborhood characteristics. *Am J Prev Med* 2007;**33**(Suppl. 4):S240–5. <http://dx.doi.org/10.1016/j.amepre.2007.07.005>
154. Reidpath DD, Burns C, Garrard J, Mahoney M, Townsend M. An ecological study of the relationship between social and environmental determinants of obesity. *Health Place* 2002;**8**:141–5. [http://dx.doi.org/10.1016/S1353-8292\(01\)00028-4](http://dx.doi.org/10.1016/S1353-8292(01)00028-4)
155. Simon PA, Kwan D, Angelescu A, Shih M, Fielding JE. Proximity of fast food restaurants to schools: do neighborhood income and type of school matter? *Prev Med* 2008;**47**:284–8. <http://dx.doi.org/10.1016/j.ypmed.2008.02.021>
156. Smoyer-Tomic KE, Spence JC, Raine KD, Amrhein C, Cameron N, Yassenovskiy V, et al. The association between neighborhood socioeconomic status and exposure to supermarkets and fast food outlets. *Health Place* 2008;**14**:740–54. <http://dx.doi.org/10.1016/j.healthplace.2007.12.001>
157. Zenk SN, Powell LM. US secondary schools and food outlets. *Health Place* 2008;**14**:336–46. <http://dx.doi.org/10.1016/j.healthplace.2007.08.003>
158. El-Sayed AM, Scarborough P, Galea S. Ethnic inequalities in obesity among children and adults in the UK: a systematic review of the literature. *Obes Rev* 2011;**12**:e516–34. <http://dx.doi.org/10.1111/j.1467-789X.2010.00829.x>
159. Bartholomew LK, Parcel GS, Kok G, Gottlieb NH. *Planning Health Promotion Programs: An Intervention Mapping Approach*, 3rd edn. San Francisco, CA: Jossey-Bass; 2011.
160. Taylor NJ, Sahota P, Sargent J, Barber S, Loach J, Louch G, et al. Using intervention mapping to develop a culturally appropriate intervention to prevent childhood obesity: the HAPPY (Healthy and Active Parenting Programme for Early Years) study. *Int J Behav Nutr Phys Act* 2013;**10**:142. <http://dx.doi.org/10.1186/1479-5868-10-142>

161. Michie S, Johnston M, Abraham C, Lawton R, Parker D, Walker A, *et al.* Making psychological theory useful for implementing evidence based practice: a consensus approach. *Qual Saf Health Care* 2005;**14**:26–33. <http://dx.doi.org/10.1136/qshc.2004.011155>
162. Abraham C, Michie S. A taxonomy of behavior change techniques used in interventions. *Health Psychol* 2008;**27**:379–87. <http://dx.doi.org/10.1037/0278-6133.27.3.379>
163. Liu J, Davidson E, Bhopal R, White M, Johnson M, Netto G, *et al.* Adapting health promotion interventions to meet the needs of ethnic minority groups: mixed-methods evidence synthesis. *Health Technol Assess* 2012;**16**(44). <http://dx.doi.org/10.3310/hta16440>
164. Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, *et al.* Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sport Exerc* 2007;**39**:1423–34. <http://dx.doi.org/10.1249/mss.0b013e3180616b27>
165. Kirkpatrick S. *Family Links Pilot Evaluation Study*. Oxford, Oxford Health Services Research Unit; 2005.
166. MacNeill V. *The Family Links Nurturing Programme: a Report of a Qualitative Evaluation of Training and Implementation*. Oxford: Family Links; 2005.
167. McEachan RRC, Santorelli G, Bryant M, Sahota P, Farrar D, Small N, *et al.* on behalf of the BiB Childhood Obesity Scientific Group. The HAPPY (Healthy and Active Parenting Programme for early Years) feasibility randomised control trial: acceptability and feasibility of an intervention to reduce infant obesity. *BMC Public Health* 2016;**16**:211.
168. Daniels LA, Mallan KM, Battistutta D, Nicholson JM, Perry R, Magarey A. Evaluation of an intervention to promote protective infant feeding practices to prevent childhood obesity: outcomes of the NOURISH RCT at 14 months of age and 6 months post the first of two intervention modules. *Int J Obes (Lond)* 2012;**36**:1292–8. <http://dx.doi.org/10.1038/ijo.2012.96>
169. Daniels LA, Magarey A, Battistutta D, Nicholson JM, Farrell A, Davidson G, *et al.* The NOURISH randomised control trial: Positive feeding practices and food preferences in early childhood – a primary prevention program for childhood obesity. *BMC Public Health* 2009;**9**:387. <http://dx.doi.org/10.1186/1471-2458-9-387>
170. Daniels LA, Wilson JL, Mallan KM, Mhrshahi S, Perry R, Nicholson JM, *et al.* Recruiting and engaging new mothers in nutrition research studies: lessons from the Australian NOURISH randomised controlled trial. *Int J Behav Nutr Phys Act* 2012;**9**:129. <http://dx.doi.org/10.1186/1479-5868-9-129>
171. Wen LM, Baur LA, Simpson JM, Rissel C, Wardle K, Flood VM. Effectiveness of home based early intervention on children's BMI at age 2: randomised controlled trial. *BMJ* 2012;**344**:e3732. <http://dx.doi.org/10.1136/bmj.e3732>
172. National Institute for Health and Care Excellence. *BMI: Preventing Ill Health and Premature Death in Black, Asian and other Minority Ethnic Groups*. Public health guideline 46. London: NICE; 2013. URL: www.nice.org.uk/guidance/ph46 (accessed 8 March 2016).

Appendix 1 Reports of studies not yet published

Ethnic differences in obesity risk factors

This work includes investigation of ethnic differences in three risk factors for childhood obesity; infant diet, infant sleep and infant physical activity

1.1 Ethnic differences in Infant Diet

1.1.1 Introduction

In the first two years of life an infant's diet changes from milk as the sole food source, to foods and beverages that reflect the family diet. This transition represents the most rapid change in diet over the life course and is the developmental period when dietary preferences and habits are first established.⁽¹⁾ Furthermore, it has been shown that inappropriate early dietary patterns that are established during weaning may persist into the second year of life and beyond.^(2, 3)

There is increasing consensus that many children consume inappropriate foods and consume food in excess of their energy requirements. A US survey of a national sample of the diets of infants and toddlers⁽⁴⁾ showed that high-salt fast foods and high-sugar snacks and drinks are commonly consumed by infants. Energy intake in infants aged 7-11 months exceeded requirements by 23%, and in one to two year olds by 30%. In addition, fruit and vegetable consumption was low, with many toddlers consuming diets that were similar to adults. Data from a UK birth cohort⁽⁵⁾ confirmed that such eating patterns are also a problem in the UK and that infants of mothers of lower education were more likely to have fizzy drinks and low-calorie soft drinks, and more likely to drink from a bottle than from a cup, both of which are associated with later obesity.

The characterisation of early life dietary patterns is essential to understand how early diet influences later outcomes. However to date there is limited evidence, particularly with regard to ethnic differences in dietary intake in early childhood. Dietary data was collected at two time points (12 months and 18 months) as part of the BIB1000 study to determine infant feeding patterns; timing of introduction of solids; intake of key indicator food groups, nutrients and dietary patterns of infants from White British and Pakistani origin. Additionally comparisons were made between the 2 time-points, to determine evidence of tracking of dietary intake between 12 and 18 months.

1.1.2 Methods

Dietary data was collected at 12 and 18 months from a validated Food Frequency Questionnaire (FFQ) from The Southampton Women's cohort study⁽⁶⁾ which was modified for use in the multi-ethnic population of Bradford. The FFQ includes a list of 98 food items and allows the frequency of consumption and amounts consumed by the infant child over the preceding month to be recorded. Flash cards, and household utensils and measures were utilised in estimating quantities of food consumed.

The statistical analysis focuses on three areas of children's diets derived from the FFQ: (1) key indicator foods, (2) nutrients, and (3) dietary patterns.

The key indicator food groups were derived from the FFQ by grouping similar types of foods e.g. high fat, high sugar, high fibre, low sugar and associated with dietary energy intake. The

key indicator food groups used in analysis are listed in Table 3. The frequency of key indicator foods was tabulated across the full cohort and by ethnic group.

No dietary guidelines currently exist for this age group in the UK so it was not possible to categorise intake into those meeting, or not meeting, recommended intake levels. For further analysis we dichotomised the food groups into either consumer/non-consumer (i.e. any intake / zero intake) or into below and above the median intake for that key indicator food group (i.e. lower intake / higher intake).

The consumption of nutrients was calculated from the FFQ responses and for the analyses presented here we considered seven nutrients; total energy intake (kcal/day), protein (g/day), fat (g/day), carbohydrate (g/day), fibre (g/day), percentage energy from fat and percentage energy from carbohydrate.

At both 12 and 18 months, a principal components analysis (PCA) was carried out based on the thirteen key indicator food groups, with varimax rotation, restricted to orthogonal rotations only to define dietary patterns. The scree plot suggested that six principal components might be informative. Six components are included before the first change of direction in the plot and six components have eigenvalues greater than one. From these six components we assigned labels to each component, whilst these labels are subjective they do describe the over-riding characteristics. Each individual was scored on these six components, these scores were then dichotomised at the median and were then used as outcomes in further analysis.

Logistic regression was used to model the association between ethnicity and the key indicator foods, nutrients and dietary patterns. All models were adjusted for mother's and father's education and mother's age at follow-up visit. Odds ratios (OR) are presented for Pakistani infants compared to White British infants.

1.1.3 Results

1.1.3.1 Key indicator food group consumption at 12 months

The associations between consumption of the key indicator food groups at 12 months and ethnicity are shown in Table 3. A number of differences were observed between the White British and Pakistani infants in the cohort; Pakistani members were less likely to consume commercial savoury baby meals and processed meat products and more likely to consume commercial sweet baby meals, chips, roast potatoes or potato shapes, vegetables, fruit, sugar-sweetened drinks and pure fruit juice than White British infants.

Table 3. Key indicator food consumption at 12 months by ethnic group, median (IQR) and odds ratio (OR) of Pakistani relative to White British from adjusted logistic regression models

Key indicator food group	Frequency of consumption (per day or per week)		Odds ratio of consumption (Pakistani relative to White British) of any or >median		
	White British	Pakistani	Adjusted OR†	95% CI	P
Formula Milk (per day)*	0.0 (0.2, 2.0)	0.0 (0.2, 2.0)	1.23	(0.95, 1.59)	0.1
Commercial savoury baby meals (per week)*	0.0 (0.0, 4.0)	0.0 (0.2, 2.0)	0.59	(0.45, 0.76)	<0.001
Commercial sweet baby meals (per week)*	0.0 (0.0, 0.0)	0.0 (0.2, 2.0)	1.90	(1.40, 2.56)	<0.001
Chips, roast and potato shapes (per week)**	1.0 (0.0, 2.0)	1.0 (0.5, 2.0)	2.75	(2.09, 3.62)	<0.001
Processed meat products (per week)**	2.0 (0.5, 4.0)	0.0 (0.0, 1.0)	0.11	(0.08, 0.15)	<0.001
Vegetables (per day)**	1.6 (1.0, 2.3)	1.8 (0.9, 2.7)	1.34	(1.03, 1.73)	0.03
Fruit (per day)**	1.5 (0.9, 2.3)	2.1 (1.3, 3.0)	2.20	(1.70, 2.85)	<0.001
Cakes, biscuits, chocolates and sweets (per day)**	0.7 (0.4, 1.2)	0.6 (0.2, 1.1)	0.75	(0.58, 0.97)	0.03
Crisps and savoury snacks (per week)**	2.0 (0.0, 3.0)	2.0 (0.0, 4.0)	1.15	(0.89, 1.49)	0.3
Sugar-sweetened drinks (per week)*	0.0 (0.0, 3.0)	0.5 (0.0, 7.0)	1.68	(1.29, 2.18)	<0.001
Pure fruit juice (per week)**	0.0 (0.0, 3.8)	1.0 (0.0, 7.0)	1.87	(1.44, 2.41)	<0.001
Low-sugar drinks (per week)*	0.0 (0.0, 2.0)	0.0 (0.0, 1.0)	0.86	(0.65, 1.14)	0.3
Water (per day)**	2.0 (1.0, 3.0)	2.0 (1.0, 3.0)	1.09	(0.84, 1.42)	0.5

*consumption of any vs none

**consumption of >median vs <median

† Model adjusted for mother's and father's highest educational qualification and mother's age at the 12 month follow-up questionnaire

1.1.3.2 Key indicator food group consumption at 18 months

The associations between consumption of the key indicator food groups at 18 months and ethnicity are shown in Table 4. There were a number of differences between the White British and Pakistani members of the cohort at 18 months. Pakistani infants were less likely to consume any formula milk, processed meat products, vegetables, and low sugar drinks and more likely to consume commercial sweet baby meals, chips, roast potatoes or potato shapes, fruit, crisps and savoury snacks, sugar-sweetened drinks, pure fruit juice and water. The relationship between ethnicity and consumption of these key indicator food groups altered between 12 and 18 months.

Table 4. Key indicator food consumption at 18 months by ethnic group, median (IQR) and odds ratio (OR) of Pakistani relative to White British from adjusted logistic regression models

	Frequency of consumption (per	Odds ratio of consumption
--	-------------------------------	---------------------------

Key indicator food group	day or per week)		(Pakistani relative to White British) of any or >median		
	White British Median (IQR)	Pakistani Median (IQR)	Adjusted OR†	95% CI	P
Formula Milk (per day)*	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.55	(0.39, 0.79)	0.001
Commercial savoury baby meals (per week)*	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.89	(0.57, 1.40)	0.6
Commercial sweet baby meals (per week)*	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	4.57	(2.49, 8.39)	<0.001
Chips, roast and potato shapes (per week)**	7.0 (7.0, 7.0)	7.0 (7.0, 7.0)	2.26	(1.50, 3.43)	<0.001
Processed meat products (per week)**	21.0 (14.0, 28.0)	7.0 (0.0, 7.0)	0.10	(0.06, 0.15)	<0.001
Vegetables (per day)**	6.0 (4.0, 7.0)	5.0 (4.0, 7.0)	0.56	(0.42, 0.74)	<0.001
Fruit (per day)**	5.0 (3.0, 6.0)	5.0 (4.0, 6.0)	1.40	(1.08, 1.81)	0.01
Cakes, biscuits, chocolates and sweets (per day)**	3.0 (2.0, 4.0)	3.0 (2.0, 4.0)	0.82	(0.63, 1.07)	0.1
Crisps and savoury snacks (per week)**	7.0 (7.0, 7.0)	7.0 (7.0, 7.0)	2.04	(1.42, 2.94)	<0.001
Sugar-sweetened drinks (per week)*	7.0 (0.0, 14.0)	7.0 (0.0, 14.0)	2.03	(1.53, 2.70)	<0.001
Pure fruit juice (per week)**	0.0 (0.0, 7.0)	7.0 (0.0, 7.0)	1.82	(1.40, 2.35)	<0.001
Low-sugar drinks (per week)*	0.0 (0.0, 14.0)	0.0 (0.0, 0.7)	0.51	(0.39, 0.67)	<0.001
Water (per day)**	1.0 (0.0, 3.0)	3.0 (1.0, 4.0)	3.24	(2.46, 4.25)	<0.001

*consumption of any vs none

**consumption of >median vs <median

† Model adjusted for mother's and father's highest educational qualification and mother's age at the 18 month follow-up questionnaire

1.1.3.3 Nutrient analysis of the FFQ at 12 months

The associations between consumption of the key nutrients at 12 months and ethnicity are shown in Table 5. Ratios of mean nutrient intakes are presented for Pakistani cohort members compared to White British. There were a number of differences between the nutrient intake in infants of White British and Pakistani mothers, with Pakistani mothers reporting providing their infants with 7% lower total energy intake (95% CI: 2% to 11%), 6% lower protein intake (95% CI: 3% to 9%), and 10% lower fibre intake (95% CI: 6% to 14%) than White British mothers.

Table 5. Key nutrient consumption at 12 months by ethnic group, mean (SD) and ratio of mean nutrient intake of Pakistani relative to White British from adjusted models

Key Nutrient	White British	Pakistani	Adjusted ratio†	95% CI	P
	Mean (SD)	Mean (SD)			
Total energy intake (kcal/day)	1169 (440)	1083 (436)	0.93	(0.89, 0.98)	0.003

Protein (g/day)	41 (17)	37 (17)	0.94	(0.91, 0.97)	<0.001
Fat (g/day)	44 (19)	41 (19)	1.02	(0.99, 1.06)	0.2
Carbohydrate (g/day)	162 (63)	150 (64)	0.98	(0.94, 1.01)	0.2
Fibre (g/day)	10.1 (4.4)	8.7 (4.1)	0.90	(0.86, 0.94)	<0.001
% energy from fat (%)	34	34	1.02	(0.99, 1.06)	0.2
% energy from carbohydrate (%)	52	52	0.98	(0.94, 1.01)	0.2

† Model adjusted for mother's and father's highest educational qualification and mother's age at the 12 month follow-up questionnaire

1.1.3.4 Nutrient analysis of the FFQ at 18 months

The associations between consumption of the key nutrients at 18 months and ethnicity are shown in Table 6. Ratios of mean nutrient intakes are presented for Pakistani infants compared to White British infants. Total energy intake and protein intake were similar in both ethnic groups and fibre intake was 7% higher (95% CI: 4% to 10%) in Pakistani infants than White British infants. Pakistani infants consumed 8% less fat (95% CI: 5% to 11%) and 7% more carbohydrate (95% CI: 4% to 10%) than White British children.

This information has not been subject to peer review

Table 6. Key nutrient consumption at 18 months by ethnic group, mean (SD) and ratio of mean nutrient intake of Pakistani relative to White British from adjusted models

Key Nutrient	White British	Pakistani	Adjusted ratio†	95% CI	P
	Mean (SD)	Mean (SD)			
Total energy intake (kcal/day)	1085 (407)	1058 (392)	0.98	(0.94,1.03)	0.5
Protein (g/day)	40 (16)	37 (14)	0.98	(0.94,1.03)	0.5
Fat (g/day)	44 (18)	44 (18)	0.92	(0.89,0.95)	<0.001
Carbohydrate (g/day)	142 (58)	136 (57)	1.07	(1.04,1.10)	<0.001
Fibre (g/day)	8 (3.5)	7 (3.4)	1.07	(1.04,1.10)	<0.001
% energy from fat (%)	36 (5.3)	36 (6.0)	0.87	(0.84,0.91)	<0.001
% energy from carbohydrate (%)	49 (6.5)	48 (7.2)	0.97	(0.94,1.00)	0.07

† Model adjusted for mother's and father's highest educational qualification and mother's age at the 18 month follow-up questionnaire

1.1.3.5 Dietary patterns analysis at 12 months

The following subjective descriptions can be derived for the first six principal components from the PCA analysis at 12 months:

- **Naughty:** Predominantly high in chips and potatoes, processed meat, sweet snacks, savoury snacks and sugar-sweetened drinks.
- **Healthy:** Low in processed meat, high in fruit, vegetables and fruit juice.
- **In a rush:** Predominantly high in commercial sweet and savoury meals, savoury snacks and low in processed meat
- **Low sugar:** High in savoury snacks and low-sugar drinks, low in sugar-sweetened drinks and pure fruit juice
- **Formula milk:** Predominantly high in formula milk, processed meat and pure fruit juice, low in sugar-sweetened drinks
- **Water:** Predominantly high in water.

Associations between component scores and ethnicity are shown in Table 7. There were a number of differences between infants of White British and Pakistani mothers, with Pakistani mothers reporting substantially greater odds of being above average on the "healthy" component, the "in a rush" component, and the "water" component than White British mothers, and lower odds of being above average in the "low sugar" component.

Table 7. Odds ratios (OR) for association between ethnic group (Pakistani compared to White British) and component scores at 12 months

	Adjusted OR†	95% CI	P
"Naughty" component	1.23	(0.94, 1.60)	0.1
"Healthy" component	2.74	(2.10, 3.58)	<0.001
"In a rush" component	2.05	(1.57, 2.68)	<0.001

"Low-sugar" component	0.61	(0.47, 0.79)	<0.001
"Formula milk" component	0.90	(0.70, 1.16)	0.4
"Water" component	1.67	(1.29, 2.16)	<0.001

† Model adjusted for mother's and father's highest educational qualification and mother's age at the 12 month follow-up questionnaire

1.1.3.6 Dietary patterns analysis at 18 months

The 18-month dietary data was used to generate a new set of principal components also retaining six components. The following descriptions can be derived for the first six principal components, and a subjective label allocated:

- **Fruit & vegetables:** Predominantly high in fruit and vegetables.
- **Processed meat:** Predominantly high in processed meat, sweet snacks and sugar-sweetened drinks.
- **Chips & crisps:** Predominantly high in chips and potatoes, and crisps and savoury snacks.
- **Commercial meals:** Predominantly high in commercial sweet and savoury meals, and fruit juice.
- **High-sugar drinks:** Predominantly high in sugar-sweetened drinks and pure fruit juice, predominantly low in low-sugar drinks.
- **Formula milk:** Predominantly high in formula milk, high in water.

These components are similar in structure to those found at 12 months, with the previous "naughty" component now finding expression in two distinct components, with the first largely covering processed meat ("processed meat") and the second covering chips and potatoes, crisps and savoury snacks ("chips & crisps"). And the previous "formula milk" and "water" components now combining into one ("formula milk"). The previous "healthy" component is similar to the new "fruit & vegetables" component, the previous "in a rush" component is similar to the new "commercial meals" component, and the previous "low sugar" component is just the same as the new "high-sugar drinks" component, but just with the scoring reversed.

The associations between component scores and ethnicity are shown in Table 8. There were a number of differences between infants of White British and Pakistani mothers, with Pakistani mothers reporting substantially lower odds of being above average on the "processed meat" component, greater odds of being above average on the "chips & crisps" component, the "commercial meals" component, and the "high-sugar drinks" component than White British mothers, and lower odds of being above average in the "formula milk" component.

Table 8. Odds ratios (OR) for association between ethnic group (Pakistani compared to White British) and component scores at 18 months.

	Adjusted OR†	95% CI	P
--	--------------	--------	---

"Fruit & vegetables" component	0.9	(0.70,1.17)	0.4
"Processed meat" component	0.13	(0.09,0.17)	<0.001
"Chips & crisps" component	1.67	(1.29,2.17)	<0.001
"Commercial meals" component	1.89	(1.46,2.45)	<0.001
"High-sugar drinks" component	2.23	(1.71,2.91)	<0.001
"Formula milk" component	0.6	(0.46,0.77)	<0.001

† Model adjusted for mother's and father's highest educational qualification and mother's age at the 18 month follow-up questionnaire

1.1.3.7 Comparison of dietary patterns at 12 months and 18 months

It is difficult to compare the PCA analysis at 12 and 18 months due to the principal components changing. Subsequently, we investigated differences between ethnic groups in terms of the same dietary patterns identified at 12 months, but applied to the 18 month data. At 12 months of age, Pakistani infants were slightly more likely than White British infants to score highly on the "naughty" component, and by 18 months this shifted to being less likely ($p=0.05$). However, their threefold advantage over White British in terms of being more likely to score highly on the "healthy" component decreased to a twofold advantage, although still better than White British infants. The biggest change was that, whilst at 12 months, Pakistani infants were twice as likely to use commercial meals, scoring highly on the "in a rush" component, this increased dramatically, so that by 18 months, Pakistani infants were even more likely to be consuming large amounts of these products ($p<0.001$). Pakistani infants continued to consume less of the "low sugar" component than White British. Whilst at 12 months, Pakistani infants were just as likely as White British to have a high intake of the "formula milk" component, by 18 months they were half as likely as their White British counterparts ($p<0.001$). The Pakistani consumption of the "water" component was much higher than that of White British consumption at 18 months ($p<0.001$).

1.1.4 Discussion

Analyses of the dietary patterns found that, by 12 months of age, foods and drinks high in sugar and foods high in fat were consumed by infants. There was no fruit and vegetable consumption in 3% of infants, a higher intake of sweet commercial foods, fruit and high sugar drinks in Pakistani infants; higher intakes of savoury baby foods and processed meat products in White British infants.

In comparison to intakes of key indicator food groups at 12 months, the 18 month data shows large statistically significant and nutritionally concerning increases in the consumption of unhealthier food items across the cohort. Large increases are observed in the intake of chips, processed meat products, savoury snacks, and sugar sweetened drinks. Encouragingly intake of fruit, vegetables and low sugar drinks has also increased.

At 18 months Pakistani infants had a higher intake of chips, roast potatoes or potato shapes and consumed substantially less processed meat than White British infants. Pakistani children continued to drink more sugar-sweetened drinks and more pure fruit juice than their White British counterparts.

There were ethnic differences in the consumption of key nutrients and these also changed over time. These changes in diet may simply reflect different weaning strategies between

the ethnic groups; with Pakistani babies breastfed for longer reflected in lower protein and fibre intakes at 12 months, but patterns relating to consumption of solid food becoming more established by 18 months.

This analysis contributes to the limited evidence of dietary patterns in early childhood and highlights ethnic differences in some consumption patterns. There is evidence of dietary patterns that emerged at 12 months tracking to 18 months, and once established may form the basis of an unhealthy diet that may become ingrained and difficult to shift. This information helps to characterise early life dietary patterns and will allow us to examine how early diet influences later outcomes. It can be used to inform the development of community-tailored and culturally appropriate obesity prevention interventions aimed at improving the nutritional health of infants, toddlers and children.

1.2 Infant sleep patterns

1.2.1 Introduction

Shorter sleep duration during infancy is associated with later childhood overweight and obesity.^(7, 8) In addition to data collected through questionnaires, we asked mothers to complete a 3-day infant sleep diary at 18 and 36 months. We describe the results from these diaries and the questionnaire data and investigate if there are ethnic differences in sleeping patterns of White British and Pakistani infants.

1.2.2 Methods

Infant sleep duration during the day time and night time was collected at each follow up visit. In addition all parents who completed the BiB1000 interviews at 18 and 36 months were asked to complete a sleep diary during the following week and return this to the BiB office. Two hundred and seventy six 18 month and 262 36 month diaries were returned, with 135 families completing both diaries. The Sleep Diary asked parents 7 questions about their infant's 'normal weekday sleep', followed by collecting sleep data for 3 specified days in the subsequent week. Each nightly diary comprised 16 questions covering the period from the child's last meal to getting up the next morning. We describe differences in sleeping patterns over time between White British and Pakistani infants as recorded at each follow up visit and we report on the timing and duration of night-time sleep as recorded in the sleep diaries.

1.2.3 Results

Mean night-time sleep duration as reported by parents at 6 monthly intervals between 6 and 24 months of age was remarkably consistent over time at 9.3 to 9.4 hours per night (SD 1.5-1.6). Mean twenty-four hour sleep was reported to decline progressively from 13.1 hours (SD 2.0) at 6 months to 12.4 (SD 1.5) at 24 months with a concomitant reduction in day-time sleep from 3.8 (SD 1.8) hours per day at 6 months to 3.1 (SD 1.8) hours per day at 24 months. A similar pattern in sleep duration was observed for each ethnic group.

The greatest change in reported sleep behaviour from the 6 to 24 month visits occurred among White British infants with 71.2% of White British boys and 69.8% of White British girls obtaining more than 12 hours sleep at 6 months, compared with 51.9% and 49.1% respectively at 24 months (reduction of 19.3% and 20.7%). In comparison 9% fewer

Pakistani boys and 12% fewer Pakistani girls were reported to sleep for more than 12 hours at 24 months than 6 months. Ethnic differences in sleeping arrangements may affect sleep duration or maternal knowledge (and subsequent reporting) of infant sleep duration.

1.2.3.1 18 month diaries

Of the 276 infants for whom parents provided data, 255 were full-term, (15 were <37 weeks gestation, 6 missing data), 145 were female, and 129 male (2 missing data). 139 infants were born to White British mothers, 95 Pakistani, and 38 other ethnicity (2 missing data). Mean child age at the completion of diary was 1.51 years.

Parent recorded sleep and wake times for one week night are presented for all infants and by ethnic group in Table 9. Infants fell asleep at 8:28pm on average, woke at 7:35am, obtained just over 11 hours of sleep and those who woke did so for just under 20 minutes. Substantial differences were observed by ethnic group, with Pakistani infants commencing sleep on average more than one and a half hours later than White British infants, and waking on average an hour and 10 minutes later. Pakistani infants experienced approximately half an hour less maximum sleep duration at night than White British infants, with night waking being of similar duration for those who woke in the night. The interview data indicate that 24 hour sleep duration did not differ by ethnicity at 18 months, so this suggests Pakistani infants obtained more daytime sleep than White British infants.

This information has not been subject to peer review

Table 9. Summary of sleep diaries at 18 and 36 months by ethnic group

	<i>All</i>	<i>White British</i>	<i>Pakistani</i>
18 months			
Sleep onset time (hh:mm)	20:28 (SD 1:19)	19:43 (SD 0:46)	21:25 (SD 1:09)
Wake time (hh:mm)	07:35 (SD 1:09)	07:02 (SD 0:54)	08:13 (SD 1:03)
Max sleep duration (hh:mm)	11:04 (SD 1:04)	11:18 (SD 1:00)	10:45 (SD 1:09)
Night wake duration(hh:mm)	0:18 (SD 0:23)	0:17 (SD 0:21)	0:21 (SD 0:30)
36 months			
Sleep onset time (hh:mm)	20:19 (SD 1:06)	19:46 (SD 0:49)	21:05 (SD 0:58)
Wake time (hh:mm)	07:31 (SD 1:03)	07:09 (SD 0:51)	08:07 (SD 1:02)
Max sleep duration (hh:mm)	11:11 (SD 0:53)	11:24 (SD 0:46)	11:02 (SD 0:59)
Night wake duration (hh:mm)	0:23 (SD 0:55)	0:32 (SD 1:11)	0:12 (SD 0:09)

1.2.3.2 36 month diaries

At 36 months, data were provided for 262 singleton infants: 244 were full-term (13 were <37 weeks gestation, 5 missing data). 121 were female, 141 were male. 139 infants were born to White British mothers, 82 to Pakistani mothers, and 40 were of other ethnicities (1 missing data). Mean child age at the completion of the diary was 3.03 years.

Overall, children fell asleep at 8:19pm on average, woke at 7:31am, obtained 11 hours 11 minutes of sleep and those who woke did so for 23 minutes (Table 9). Substantial differences are again observed by ethnic group in sleep onset and wake times. Sleep onset time for White British was almost unchanged from 18 months but for Pakistani children was 20 minutes earlier, reducing the gap between the groups. Wake times were also moved closer together. Due to the earlier average sleep onset time Pakistani children at 36 months experienced increased maximum sleep duration (just over 11 hours) compared with 18 months. This may reflect reduced day-time sleep opportunities that occur in the UK with the onset of nursery education at 3 years of age.

1.2.4 Discussion

We found ethnic differences in night time sleeping patterns with later sleep onset and wake times for Pakistani infants compared to White British infants at both 18 and 36 months, with Pakistani infants experiencing less maximum sleep duration. Ethnic differences in sleeping arrangements may be affecting sleep duration or maternal knowledge of infant sleep duration. For example, South Asian families tend to practice familial co-sleeping with all children sharing a room for sleep with their parents while White British families practice separate sleeping arrangements, often with one room per child. Such differences may therefore affect maternal knowledge of an infant's sleep duration such that South Asian mothers may be more likely to be aware of night-wakings. Sleep duration may also be affected if family members are more frequently disturbed by one another in the night.

1.3 Physical Activity**1.3.1 Introduction**

Low levels of physical activity and high levels of sedentary behaviour are likely to be important contributing factors to childhood obesity.⁽⁹⁻¹²⁾ The UK national guidelines are for early years children (aged 0-5 years old) to take part in 180 minutes of physical activity each day and to minimise sedentary time (being restrained or sitting for extending periods, except time spent sleeping).⁽¹³⁾ Recent evidence suggests that UK children in their early years are not achieving this target^(13, 14) and are spending high proportions of their time being sedentary.^(15, 16) In South Asian adults⁽¹⁷⁾ and school aged children living in the UK⁽¹⁸⁾ levels of physical activity have been reported to be substantially lower than levels in White Europeans. Whether these differences emerge in early childhood and whether there are differences in the possible determinants of physical activity between ethnic groups is unknown.

1.3.2 Methods

Mothers completed a physical activity and sedentary behaviour questionnaire (BB1000-PA) which was validated against accelerometry. For the purpose of validation, 95% limits of agreement for total physical activity and sedentary behaviour between parent report and accelerometry were calculated using the technique of Bland and Altman⁽¹⁹⁾. Daily time spent in physical activity and sedentary behaviour reported by 709 White British and Pakistani mothers were included in the analysis. Data were excluded from analysis if ≤ 5 hours of physical activity plus sedentary behaviour, or ≥ 18 hours of physical activity plus sedentary behaviour was reported ($n = 361$), or if covariable data were missing ($n = 11$). Ethnicity was categorised into White British ($n=323$) or Pakistani ($n = 386$).

Physical activity and sedentary behaviour data were assessed for normality and were found to be normally distributed. Differences in physical activity and sedentary behaviour at age 2 were compared between the two ethnic groups using ANCOVA. Child gender, Index of Multiple Deprivation (IMD) quintile (1 = most deprived, 5 = least deprived), parity (0, 1, 2, or 3+) and mother's age were identified as potential influences upon physical activity and sedentary behaviour and thus were included as covariates. Mother's BMI (collected during pregnancy between 8 and 12 weeks) was considered as a covariate, however data were missing from 66 mothers. The analysis was run both with and without including mothers BMI as a covariate, and no significant influences of mothers BMI was found, thus mother's BMI was excluded from the final analysis.

Mothers answered validated questions regarding possible determinants of physical activity⁽²⁰⁾; these included questions about parental support, parental restrictions, maternal attitudes and perceptions, and barriers to physical activity. For each determinant, mothers were categorised into 2 or 3 groups depending on their answer to the question. Differences between the group in time spent in physical activity and sedentary behaviour by the children were compared using ANCOVA with child gender, IMD quintile, parity, mother's age, and ethnicity as covariates.

The differences between ethnic groups in possible determinants of physical activity and sedentary behaviour at 2 years were analysed using ANCOVA controlling for child gender, IMD quintile, parity and mother's age. All mothers who answered these questions from the BiB1000 questionnaire and had covariate data were included in this analysis (total = 1040, White British = 445, Pakistani=596).

1.3.3 Results

1.3.3.1 Ethnic differences in physical activity and sedentary behaviour at age 2

Overall, 80.6% of children met the UK national physical activity guidelines of 180 minutes of physical activity each day. Mean total daily physical activity and sedentary time for the children reported by the different ethnic groups is displayed in Table 10; there were no differences between the ethnic groups for any of the variables. There were, however, significant differences between the ethnic groups in the types of physical and sedentary activities engaged in. Pakistani mothers reported that their children spent significantly more time playing actively inside the house, less time playing actively in the garden/yard, in organised physical activity programmes or walking from place to place (e.g. to local shops), compared to White British mothers. The Pakistani children spent significantly less time in proactive sedentary activities each day (colouring, sitting playing with toys, reading, and sitting listening/singing to music) and engaged in more passive sedentary activity (TV and DVD viewing) each day compared to the White British children (Table 10).

Table 10. Ethnic differences in daily physical activity and sedentary behaviour (mean minutes per day (SD))

	All (n = 710)	White British (n = 323)	Pakistani (n = 387)	P value
Percentage meeting physical activity guidelines	80.6 %	80.5%	80.5%	0.6
Total daily physical activity	312 (152)	319 (157)	305 (147)	0.3
Playing actively inside the house	214 (127)	190 (121)	235 (128)	<0.001
Playing actively in the garden/yard	47 (59)	55 (65)	40 (52)	0.001
Organised physical activity programme (% participating in activity)	18.4%	29%	10%	<0.001
Walking to get from place to place	18 (26)	25 (31)	12 (20)	<0.001
Total daily sedentary behaviour	243 (137)	257 (131)	230 (141)	0.07
Colouring/drawing/craft	18 (28)	21 (25)	16 (31)	0.02
Sitting playing with toys	88 (87)	100 (88)	78 (84)	0.006
Watching TV/DVDs	87 (82)	73 (70)	99 (89)	<0.001
Playing on the computer ^a (% participating in activity)	12%	14%	11%	0.02
Sitting listening/singing to music	24 (36)	32 (42)	16 (29)	<0.001
Reading/being read to	21 (27)	29 (34)	14 (18)	<0.001

Model is adjusted for: child gender, IMD quintile, parity and mother's age. P-value for difference between ethnic groups

^a Due to low numbers, this is presented as a percentage of children reported as any 'playing'

1.3.3.2 Determinants of physical activity and sedentary behaviour at age 2 and differences between ethnic groups

Compared to boys, girls took part in significantly less physical activity (327 ± 158 versus 297 ± 144 minute per day, $p = 0.008$) and more sedentary behaviour (230 ± 136 versus 253 ± 137 minutes per day, $p = 0.03$). There were no significant differences in child's physical activity and sedentary time between IMD quintiles, parity groups, or mothers of different ages ($p > 0.05$).

This information has not been subject to peer review

Table 11. Reported time (mean minutes per day (SD)) spent in physical activity according to categories of the determinants of physical activity

	Never	Sometimes	Everyday	P value
Barriers to physical activity				
Weather	337 (151)	299 (150)	-	0.004
Too busy	323 (158)	288 (135)	-	0.02
Cost of activities/clubs	311 (155)	319 (134)	-	0.8
Travel	314 (151)	312 (148)	-	0.7
Worried child might get hurt	314 (157)	288 (133)	-	0.2
No adult supervision	313 (153)	279 (144)	-	0.09
Can't take child on their own	318 (153)	286 (155)	-	0.07
No one else for child to play with	313 (153)	295 (143)	-	0.5
Parent support for physical activity				
Encouraged child	315 (156)	305 (158)	315 (142)	0.8
Participated with child	-	310 (158)	312 (145)	0.7
Takes child to places to be physically active	-	312 (149)	-	-
Parent restrictions				
TV restricted	321 (154)	307 (151)	298 (148)	0.3
Outside play restricted	311 (142)	298 (151)	347 (174)	0.01
Parent perceptions and attitudes				
	Less active	Similarly active	More active	
Compared to peers child is...	-	297 (145)	336 (158)	0.002
	Disagree	Neutral	Agree	
It is important that my child doesn't watch too much TV	-	296 (157)	321 (149)	0.008

Model is adjusted for: child gender, IMD quintile, parity, mother's age and ethnicity.
 - the percentage of the sample reporting this category is <10%.
 P-value for difference between ethnic groups

Mothers who reported that the weather, or being too busy, were “never” barriers to their child’s participation in physical activity reported that their children spent more time each day in physical activity compared to mothers who reported that these variables were “sometimes” a barrier to participation (Table 11). There were no other significant associations between physical activity and any of the other barriers to physical activity. There were differences between the ethnicities in the reported barriers to children’s physical activity. White British mothers reported that the cost of child activity clubs (e.g. soccer tots) or leisure facilities (e.g. swimming pool) was more often a barrier than Pakistani mothers (Table 12). Pakistani mothers reported that the following were more often barriers compared to White British mothers: the weather, being busy, worried that their child might get hurt, not able to take them out on their own and no adult to supervise child playing (Table 12).

This information has not been subject to peer review

Table 12. Differences in possible determinants of physical activity between ethnic groups

Model is adjusted for child gender, IMD quintile, parity and mother's age.

P-value for difference between ethnic groups

	White British				Pakistani			P value
	Never (%)	Sometimes (%)	Everyday (%)	Never (%)	Sometimes (%)	Everyday (%)		
Barriers to physical activity	Weather	40	56	4	33	58	9	0.003
	Too busy	72	27	0.5	58	32	9	<0.001
	Cost of activities/clubs	77	20	2.4	87	12	2	<0.001
	Travel	78	19	3	70	22	7	0.06
	Worried child might get hurt	94	4	1	71	18	12	<0.001
	No adult supervision	94	5	0.9	88	8	3	0.009
	Can't take child on their own	89	9	2.2	73	20	7	<0.001
	No one else for child to play with	90	9	0.7	85	1	2	0.05
Parent support for physical activity	Encouraged child	6.6	35	59	21	37	42	<0.001
	Participated with child	0.5	42	57	10	44	45	<0.001
	Takes child to places to be physically active	2.6	86	12	18	77	5	<0.001
Parent restriction	TV restricted	34	33	33	52	29	19	<0.001
	Outside play restricted	49	35	16	41	39	16	0.2
Parent perception and attitudes	Compared to peers child activity is...	Less	Similar	More	Less	Similar	More	0.09
	It is important that my child doesn't watch too much TV	Disagree	Neutral	Agree	Disagree	Neutral	Agree	<0.001

There were no differences in children's time spent physically active between parents who supported their children to be physically active every day and those who did not (Table 12). There were differences between the ethnicities in the support that parents gave their children to be physically active. White British mothers encouraged their children to be physically active, participated in physical activity with their child, and took them to places to be physically active more often than Pakistani mothers (Table 12).

Parents who restricted their child playing outside "everyday" reported more physical activity than those who "sometimes" or "never" restricted playing outside (Table 12). There were no differences in physical activity or sedentary behaviour according to how often parents restricted TV viewing. White British mothers restricted their child's amount of TV viewing significantly more often than Pakistani mothers; however there were no differences between the groups in restrictions upon children playing outside (Table 12).

Ninety six percent of mothers perceived that their children enjoyed being physically active and 96% of mothers agreed with the statement "I think it's important that my child is physically active." Parents who perceived their child to be more active than their peers (59%) reported more physical activity compared to children who were similarly active to peers (39%) (Table 11). There were no ethnic differences in mothers' perceptions of their child's enjoyment of physical activity or their child's physical activity level.

Three quarters of mothers agreed with the statement "I think it's important that my child doesn't watch too much TV", these mothers reported more time in physical activity and less time sedentary and watching TV/DVDs for their child (Table 11) compared with those who were neutral. Mothers' attitudes towards TV viewing were significantly different between the ethnic groups, with more White British mothers agreeing that not watching too much TV was important for their child compared to Pakistani mothers (Table 12).

1.3.4 Discussion

The majority of children in the BiB1000 cohort at age 2 were meeting the Chief Medical Officer's guidelines for physical activity of 180 minutes of physical activity each day⁽¹³⁾. This is comparable to recent accelerometer derived physical activity data from Canada which reports 73-100% of children aged 3-4 years meeting the 180 minutes guidelines.⁽²¹⁻²³⁾ However it contradicts previous data from the UK where proxy-reports of pre-school children's physical activity shows low levels of engagement,⁽²⁴⁾ with 3-4 years olds spending on average 120-150 minutes per day in physical activity and high amounts of time sedentary.⁽²⁵⁾ The discrepancies in reported physical activity between studies are likely to be due to methodological differences in measurement which is not standardised for children in the early years.

There were no differences between the ethnic groups in time spent in daily total physical activity and sedentary behaviour and TV/DVD viewing was high for the whole group (on average an hour and a half per day). There were however ethnic

differences in the types of physical and sedentary activities the children engaged in. White British children were reported to spend longer walking, in organised physical activity, playing outside and in proactive sedentary behaviours (e.g. being read to) compared to Pakistani children who spent longer each day playing inside and in passive sedentary behaviour (watching TV/DVDs). The Pakistani mothers were more likely to report either being neutral to or disagreed with the statement, "I think it's important that my child doesn't watch too much TV". Although this attitude towards sedentary behaviour was not related to time spent in physical activity or sedentary behaviour in the children at aged 2, it is possible that it could contribute to the differences in physical activity and sedentary behaviour between ethnic groups which have been reported later in childhood.⁽¹⁸⁾ The differences in times spent in different types of activities may be important lifestyle differences as the children grow up since observational studies have shown that time outdoors correlate with PA levels in school-aged children.^(26, 27) Time outdoors has also been associated with higher objectively measured physical activity^(28, 29) and with lower prevalence of overweight.⁽²⁸⁾ There were other marked differences between the ethnicities in possible determinants of physical activity and sedentary behaviour which may also contribute to the reported differences between ethnic groups later in childhood.⁽¹⁸⁾ These include Pakistani children being less frequently restricted in their TV viewing, having more barriers to physical activity, and receiving less frequent support to be physically active from their parents.

Children whose parents restricted them from spending time outside everyday were reported to engage in more physical activity. This may indicate that parenting styles influence participation in physical activity at age 2. Studies with older children have reported significant associations between parenting style and physical activity;⁽³⁰⁻³²⁾ however there is no consensus regarding the parenting style that best facilitates engagement in physical activity. Further work is required to understand better the influences of parenting upon childhood physical activity and sedentary behaviours.

References

1. Birch L, Savage JS, Ventura A. Influences on the Development of Children's Eating Behaviours: From Infancy to Adolescence. Canadian journal of dietetic practice and research : a publication of Dietitians of Canada = Revue canadienne de la pratique et de la recherche en dietetique : une publication des Dietetistes du Canada. 2007;68(1):s1-s56. PubMed PMID: 19430591. Pubmed Central PMCID: 2678872.
2. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. Pediatrics. 1998 Mar;101(3 Pt 2):539-49. PubMed PMID: 12224660.
3. Trost SG, Sirard JR, Dowda M, Pfeiffer KA, Pate RR. Physical activity in overweight and nonoverweight preschool children. International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity. 2003 Jul;27(7):834-9. PubMed PMID: 12821970.
4. Ponza M, Devaney B, Ziegler P, Reidy K, Squatrito C. Nutrient intakes and food choices of infants and toddlers participating in WIC. Journal of the American Dietetic Association. 2004 Jan;104(1 Suppl 1):s71-9. PubMed PMID: 14702021.

5. Northstone K, Rogers I, Emmett P. Drinks consumed by 18-month-old children: are current recommendations being followed? *European journal of clinical nutrition*. 2002 Mar;56(3):236-44. PubMed PMID: 11960299. Epub 2002/04/18. eng.
6. Marriott LD, Robinson SM, Poole J, Borland SE, Godfrey KM, Law CM, et al. What do babies eat? Evaluation of a food frequency questionnaire to assess the diets of infants aged 6 months. *Public Health Nutr*. 2008 Jul;11(7):751-6. PubMed PMID: 18005490.
7. Monasta L, Batty GD, Cattaneo A, Lutje V, Ronfani L, Van Lenthe FJ, et al. Early-life determinants of overweight and obesity: a review of systematic reviews. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 2010 Oct;11(10):695-708. PubMed PMID: 20331509. Epub 2010/03/25. eng.
8. Taveras EM, Rifas-Shiman SL, Oken E, Gunderson EP, Gillman MW. Short sleep duration in infancy and risk of childhood overweight. *Archives of pediatrics & adolescent medicine*. 2008 Apr;162(4):305-11. PubMed PMID: 18391138. Pubmed Central PMCID: 2650815.
9. Epstein LH, Paluch RA, Gordy CC, Dorn J. Decreasing sedentary behaviors in treating pediatric obesity. *Archives of pediatrics & adolescent medicine*. 2000 Mar;154(3):220-6. PubMed PMID: 10710017.
10. Department of Health. At least five a week: Evidence on the impact of physical activity and its relationship to health. A report from the Chief Medical Officer. 2004.
11. Janz KF, Kwon S, Letuchy EM, Eichenberger Gilmore JM, Burns TL, Torner JC, et al. Sustained effect of early physical activity on body fat mass in older children. *American journal of preventive medicine*. 2009 Jul;37(1):35-40. PubMed PMID: 19423269. Pubmed Central PMCID: 2760597.
12. Martinez-Gomez D, Eisenmann JM, Tucker J, Heelan KA, Welk GJ. Associations between moderate-to-vigorous physical activity and central body fat in 3-8-year-old children. *International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity*. 2011 Jun;6(2-2):e611-4. PubMed PMID: 21091103.
13. Department of Health PA, Health Improvement and Protection. Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers. 2011.
14. Reilly JJ, Okely AD, Almond L, Cardon G, Prosser L, Hubbard J. Making the Case for UK Physical Activity Guidelines for Early Years: Recommendations and draft summary based on the current evidence. Working paper 2009. 2009.
15. O'Dwyer MV, Fowweather L, Stratton G, Ridgers ND. Physical Activity in non-overweight and overweight UK preschool children: Preliminary findings and methods of the Active Play Project. *Science and Sports*. 2011;26(6):345-9.
16. Reilly JJ, Jackson DM, Montgomery C, Kelly LA, Slater C, Grant S, et al. Total energy expenditure and physical activity in young Scottish children: mixed longitudinal study. *Lancet*. 2004 Jan 17;363(9404):211-2. PubMed PMID: 14738795. Epub 2004/01/24. eng.
17. Fischbacher CM, Hunt S, Alexander L. How physically active are South Asians in the United Kingdom? A literature review. *Journal of public health*. 2004 Sep;26(3):250-8. PubMed PMID: 15454592.

18. Owen CG, Nightingale CM, Rudnicka AR, Cook DG, Ekelund U, Whincup PH. Ethnic and gender differences in physical activity levels among 9-10-year-old children of white European, South Asian and African-Caribbean origin: the Child Heart Health Study in England (CHASE Study). *International journal of epidemiology*. 2009 Aug;38(4):1082-93. PubMed PMID: 19377098. Pubmed Central PMCID: 2720395.
19. Bland JM, Altman DG. Statistical-Methods for Assessing Agreement Between 2 Methods of Clinical Measurement. *Lancet*. 1986 1986;1(8476):307-10.
20. McMinn AM, van Sluijs EM, Harvey NC, Cooper C, Inskip HM, Godfrey KM, et al. Validation of a maternal questionnaire on correlates of physical activity in preschool children. *The international journal of behavioral nutrition and physical activity*. 2009;6:81. PubMed PMID: 19954524. Pubmed Central PMCID: 2791748.
21. Gabel L, Proudfoot NA, Obeid J, MacDonald MJ, Bray SR, Cairney J, et al. Step count targets corresponding to new physical activity guidelines for the early years. *Medicine and science in sports and exercise*. 2013 Feb;45(2):314-8. PubMed PMID: 22968313.
22. Obeid J, Nguyen T, Gabel L, Timmons BW. Physical activity in Ontario preschoolers: prevalence and measurement issues. *Applied physiology, nutrition, and metabolism = Physiologie appliquee, nutrition et metabolisme*. 2011 Apr;36(2):291-7. PubMed PMID: 21609292.
23. Colley RC, Garriguet D, Adamo KB, Carson V, Janssen I, Timmons BW, et al. Physical activity and sedentary behavior during the early years in Canada: a cross-sectional study. *The international journal of behavioral nutrition and physical activity*. 2013;10(1):54. PubMed PMID: 23642258. Pubmed Central PMCID: 3655822.
24. Oliver M, Schofield GM, Kolt GS. Physical activity in preschoolers: understanding prevalence and measurement issues. *Sports medicine*. 2007;37(12):1045-70. PubMed PMID: 18027093.
25. Booth M. Assessment of physical activity: an international perspective. *Research quarterly for exercise and sport*. 2000 Jun;71(2 Suppl):S114-20. PubMed PMID: 10925833.
26. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Medicine and science in sports and exercise*. 2000 May;32(5):963-75. PubMed PMID: 10795788.
27. Ferreira I, van der Horst K, Wendel-Vos W, Kremers S, van Lenthe FJ, Brug J. Environmental correlates of physical activity in youth - a review and update. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 2007 Mar;8(2):129-54. PubMed PMID: 17300279.
28. Cleland V, Crawford D, Baur LA, Hume C, Timperio A, Salmon J. A prospective examination of children's time spent outdoors, objectively measured physical activity and overweight. *International journal of obesity (2005)*. 2008 Nov;32(11):1685-93. PubMed PMID: 18852701.
29. Cooper AR, Page AS, Wheeler BW, Hillsdon M, Griew P, Jago R. Patterns of GPS measured time outdoors after school and objective physical activity in English children: the PEACH project. *The international journal of behavioral nutrition and physical activity*. 2010;7:31. PubMed PMID: 20412582. Pubmed Central PMCID: 2867989.
30. Jago R, Davison KK, Brockman R, Page AS, Thompson JL, Fox KR. Parenting styles, parenting practices, and physical activity in 10- to 11-year olds. *Preventive*

medicine. 2011 Jan;52(1):44-7. PubMed PMID: 21070805. Pubmed Central PMCID: 3025352.

31. Hennessy E, Hughes SO, Goldberg JP, Hyatt RR, Economos CD. Parent-child interactions and objectively measured child physical activity: a cross-sectional study. *The international journal of behavioral nutrition and physical activity*. 2010;7:71. PubMed PMID: 20929570. Pubmed Central PMCID: 2964559.

32. Saunders J, Hume C, Timperio A, Salmon J. Cross-sectional and longitudinal associations between parenting style and adolescent girls' physical activity. *The international journal of behavioral nutrition and physical activity*. 2012;9:141. PubMed PMID: 23199218. Pubmed Central PMCID: 3541158.

1.4 Investigation of social and environmental determinants of childhood obesity

A qualitative exploration into determinants of childhood obesity

1.4.1 Background

What stops us grasping what people are up to is a lack of familiarity with their personal imaginative universe⁽¹⁾.

Obesity is linked to a medically defined anatomical measurement and used as both a disease category, "you are obese", or as risk assessment, "your chances of illness are greater"⁽²⁾. Simply bringing these categories into diagnostic or screening protocols does not mean they enter into lay discourse as anything other than one of several factors impacting on self-perception. One's size, and whether it is of concern to an individual, is not a simple artefact of a diagnostic or risk discourse. In lay discourse it is structured through a comparative measure: am I (or is my baby) overweight in relation to those around me; a chronological measure, how is my weight compared to how I was, or even to how my parent was; and, a socially conditioned measure which is in part shaped by a (changing) media ideal.^(3, 4) In considerations of body size and of eating and exercise we cannot assume that making these areas public issues has meant they become something that is recognised as personal troubles.⁽⁵⁾

1.4.2 Evidence in existing qualitative literature

A systematic review of qualitative studies⁽⁶⁾ reports a literature where parents attitudes to feeding their young children reflect a belief that the child is "picky", "fussy", "difficult", "always seeming hungry", and so on. Family dynamics, both between the parents and with other family members, also shape attitudes and behaviour. Different attitudes to being a parent, and different sets of knowledge about the desirable and the possible, both in terms of what healthy behaviour is and about what can and should be encouraged and supported, are also reported. Looking beyond the family, there are extra-familial influences including from friends, neighbourhoods, and the environment in which the family is living. There is also an influence that is attributed to the type and amount of resources available for the family. Intergenerational influences on parental health beliefs and knowledge suggest that health promotion strategies may be more effective if directed at the

wider family, rather than parents alone. Significantly, many parents believed strategies to promote healthy weight should start early in a child's life. This study summarises the range of relevant influences by using a "socio-ecological model" where individual, interpersonal, community, organisational and societal levels interact in complex ways to impact on parental perceptions about healthy behaviours for preventing child overweight.

In addition to this systematic review there is other qualitative evidence that points to the importance of intergenerational influences, specifically grandmothers. This seems particularly evident in understanding what constitutes an appropriate size for a "healthy baby", big babies are seen as healthy babies^(7, 8).

A systematic review of lay (mostly parental) views about infant size and growth⁹ found that perceptions about what was a healthy size and healthy rate of growth were arrived at via comparison with what was considered by parents to be normal; parents valued their child being like everyone else. There was recognition that infants will differ in size, and differences in parental size, feeding practices, or the presence of specific "medical" reasons why an infant was a different size were invoked as explanations. If these explanations were not available, and parents thought their child was different to others, they were likely to express concerns. The idea of the normal is gathered from various sources; a straightforward comparison with other infants they see, conversations with health professionals especially around growth charts (where parents want reassurance their infant is normal) and comparison with social signifiers of normality like infant clothes sizes. Lucas et al⁹, in this review, do wonder about the impact of cohort changes; "The value placed by parents on being like everyone else has implications for health promotion messages. If trends in infant size continue towards greater fatness, "being normal" will include infants who are fatter than those in the past"⁽⁹⁾.

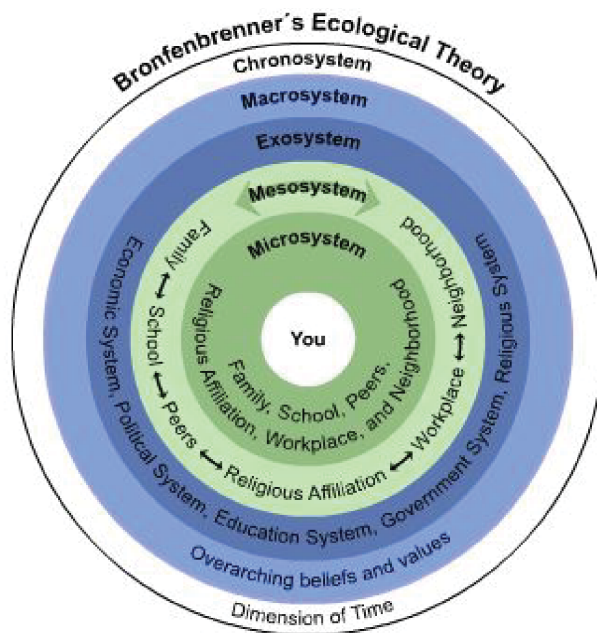
A study on initiating and then sustaining exclusive breastfeeding in South Asian women found that a clinic based peer support worker did not significantly increase breastfeeding. In considering the difficulties of shaping appropriate, acceptable and effective interventions it was noted that there is an absence of evidence about variations in the effectiveness of interventions according to ethnicity, socioeconomic status or an interaction of both⁽¹⁰⁾. At the very least we cannot assume that interventions designed to be appropriate for low income families will be appropriate for low income South Asian families, and vice versa.

As well as seeking to illuminate parental perceptions there are some qualitative studies that have provided evidence of the way that Asian women are stereotyped by professionals who use "Asian family" as a metonym of "supportive and helpful"⁽¹¹⁾. Such discourse is a short step away from legitimising an approach to service development that builds on an assumption that little is needed because they "look after their own"⁽¹²⁾, or paradoxically identifies health problems in Asian communities as a manifestation of cultural practices.⁽¹³⁾

Pocock et al's review⁽⁶⁾ uses a socio-ecological approach^(14, 15) to capture the range of influences that are relevant to childhood obesity prevention. There are areas that are best understood in terms of individual influence, interpersonal, community, organisational and societal zones. (Bronfenbrenner uses the terminology of micro, meso, exo and macro systems and also uses the dimension of time; a chronosystem⁽¹⁵⁾ see figure 3). For example a child's personality and mood will have an influence on food preferences. So too will parental choices and peer influences, which in turn are shaped by media and marketing. If the child spends time in day-care then organisational choices also determine some food intake. (A survey in 2010 reported that the average toddler typically has almost 30% of their meals provided by people other than their parents (typically grandparents, child minders and nurseries)⁽¹⁶⁾). All of these influences will change over time. An intervention in any one zone is only likely to succeed if other zones support it. It is not likely to succeed if one wishes to act in one zone on behaviour/choices that are determined in another.

This information has not been subject to peer review

Figure 3: Bronfenbrenner Ecological Theory(15)



Our concern is focussed on early feeding practices in the context of a population where half the parents are of South Asian origin (predominantly Pakistani). This prompts some modification/addition to the Bronfenbrenner schema. In Bradford's Pakistani households (when compared to White British families) less mothers have had a formal involvement in the work-force; more live in extended family households; many have grown up in Pakistan, moving to the UK after their school years; most have an active engagement with their Mosque, a place not just for spiritual sustenance but a focus for worldly advice and for socialising⁽¹⁷⁾. These factors suggest that attitudes and practices developed in Pakistan may have considerable salience – for example around cooking styles/materials used and around perceptions of what is a desirable (and healthy) size for babies.

1.4.3 Method

45 mothers who had consented to be in the Born in Bradford study were contacted by letter when their baby was about 3 months old. The procedure for choosing who to invite to join the study involved purposive sampling, using data from the baseline questionnaire. Eight categories were identified (see Table 13).

Table 13. Purposive sampling categories

Mothers of Pakistani Origin	White mothers
a first baby where mother has a high BMI	a first baby where mother has a high BMI
a first baby where mother has a normal BMI	a first baby where mother has a normal BMI
with other children	with other children
living with extended family	
living in a nuclear family	

Mothers in all the purposive sampling categories were recruited and in total 14 mothers were interviewed. Interviews were scheduled so that the baby was around 4 months old with the expectation that the focus of the interview would be breastfeeding and weaning.

Table 14. Details of interviews

Mothers seen when baby was between 3 and 5.5 months old 3 not recorded, 11 recorded All interviews conducted in English except 1 in Mirpuri (baby's paternal grandmother in interview also. This interview was not recorded)
<i>Who was interviewed</i>
There was at least one mother in each of the purposive sampling categories. 2 interviews had fathers there who talked, and 2 others where father was there but didn't talk. 1 Grandmother. 5 white British mothers – 9 Pakistani. For 5 mothers it was their 1 st baby (3 white and 2 Pakistani mothers)

The study involved visits to participants' homes. Interviews lasted between 15 minutes and one hour. With the participants consent the interview was tape recorded and subsequently transcribed and translated where necessary. In five of the interviews a husband/partner or relative was present.

The researcher in each interview, sought to elicit the interviewee's responses in three areas:

1. What does the interviewee believe is a healthy diet for the baby, what does a healthy baby look like?
2. Who in the family makes choices about diet for the baby, are these choices influenced by advice from professionals eg Health Visitor or Children's Centre staff?
3. How far does the interviewee feel able to make decisions regarding the baby?

The full discussion guide can be found in appendix 2.1. Ethics approval was given by Bradford NHS Research Ethics Committee.

1.4.6 Data analysis

Transcripts were independently coded by both authors. Analysis sought to identify emerging themes using a thematic narrative approach⁽¹⁸⁾. Deviant cases were noted and analysed.

1.4.7 Results

The emerging themes differed from the intentions of the interview, described above. There was a preoccupation with sources of advice and support and with decisions about initiating and sustaining breastfeeding, with an allied concern about weaning. Not surprisingly there was some overlap between these themes. There was also considerable shared ground between White and Pakistani mothers. Mothers expressed some anxiety about very underweight babies but a concern with them being overweight was not strongly evident, “it’s a problem for the future, an issue with older children”. If they think the child is underweight then they may encourage them to eat “even if they are not hungry”. For younger children who might be overweight the expectation (hope) was that “they will grow out of it” and with older children the problem was seen as a cosmetic rather than primarily a health concern. The context also reflected a sense of mothers having busy lives where many demands were made upon them. There is unlikely to be much time to prepare food and food can prove a valuable reward or distraction, perhaps augmented with TV time.

1.4.8 Initiating and sustaining breastfeeding

Although Mothers were interviewed when babies were between three and five and half months old there were only two White Mothers and one Pakistani Mother still breastfeeding. Half of the others had tried, averaging between a week and 10 days, then stopped. The most common answer as to why they had stopped was, “baby was not getting enough food”. As well as baby led reasons another common response was, “I tried breast feeding but I gave up. It’s better now that I’m not doing it, for me I get sleep, for baby I know what baby gets”. For some the crucial factor was support; “My husband was off (work) for a couple of weeks and I got a lot of support, I felt I could give baby 100% and it gradually got easier and easier.”

For those who had not breastfed the importance of decisions arrived at either during pregnancy, or very soon after birth, was stressed. A decision not to breastfeed, arrived at before the birth, is unlikely to be changed; “I didn’t give it to my first daughter so I won’t give it to her – I’m scared. I’ve never tried it”. Some Mothers had tried, “I tried it with my first, it didn’t work, so didn’t want to try again.”

Some Mothers were conflicted, they wanted to try; “When I went into labour they put them fluids on and...I asked the midwife if I can give it to her and she was saying ‘oh you have got them fluids inside you so you can’t give it to her’. From then I started to give bottles and I thought it was best for her to just start giving her bottles

instead of my own.” Another Mother said; “Labour was induced, and baby and me were very sleepy, he wasn’t latching on”.

A feature of many accounts (and considered in more detail below) was a sense of conflicting advice; “We were getting different advice (from hospital staff) which I found very worrying”. “I was concerned he wasn’t taking enough. Family members said, ‘maybe you are not producing enough, you might need to bottle feed.’”

But some Mothers reported no sense of being conflicted. One 18 year old white mother, living with her partner and their first baby, gives baby formula and food “from jars”. She wasn’t sure what the fuss was about; “I do what’s easiest, it’s easy this. I’ve no worries, no concerns”. (This was the interview that took 15 minutes!)

This information has not been subject to peer review

1.4.9 Weaning

Most Mothers interviewed were weaning already, often starting at around 4 months. They were using baby rice or food from “jars”. Some Mothers reported they were also cooking their own food for baby. Pakistani Mothers were less prepared to say what they fed babies. Those who did discuss this described giving lentils and spices early on after weaning, “baby is not just given sweet food”. Mothers talked of getting them used to a Pakistani diet: at weaning they get baby rice but the intention is to move as soon as possible to what the rest of the family eat, via jar foods and puree fruits. Some Mothers had heard from health visitors ideas about baby-led weaning, but none reported trying this.

Mothers were aware that there was guidance from health visitors about the correct time to wean. But there was a common complaint from those with older children that they had been told something different with this baby than they had heard before. They report the Health Visitor as saying 5 or 6 months, but the previous guidelines said 4 months.

There were stories about difficulties in both starting weaning and in delaying it. “When she was about 4 months I tried giving her cereal....but I’ve stopped and put her back on milk”. One mother said her baby was now five and a half months and she would have started weaning at about 4 months but didn’t because of the guidelines she had been told about. But she feared baby was not getting enough sleep.

The importance of what were seen as particularities of the child were reported. The child played an active part in food choices and not all children were the same. This one might be “a picky eater”, or “not like exercise”. Having more than one child created problems if their needs were very different, and there was a wish to reconcile their preferences and schedules.

1.4.10 Sources of advice and support

There were two strong, and interrelated, themes here; the importance of consistent advice was frequently reported, as was the many sources of advice that were available.

This Mother’s intention was to breastfeed, “we were getting different advice (in hospital) with the day staff and getting different advice from the night staff about breastfeeding and what to do and how to feed him, so that initially was quite worrying.” The same challenge of reconciling different advice also applied to weaning, “My Mother wanted me to wean at 4 months but the health visitor said no....it’s confusing really when you go on the internet people start at 4 months.”

One of the challenges of getting consistent advice was the wide range of sources of voices a new Mother heard. One reported getting advice from her Mother, her sister and her sisters friends, “all with kids”, from a nursery nurse at a health centre where her GP was based, from one midwife at the birth and then from three different ones after the birth, and from health visitors, “I just think the health visitor sometimes is

very sketchy on the information they give you". Most Mothers just wanted Health Visitors to tell them "if baby was OK". This was reported in relation to discussion about centile charts in the "Red Book". Two Mothers understood them, one was a nurse and one a dental nurse. All the others said they didn't know what they were.

The Internet was commonly reported as a place to get information and advice, not just specific sites like *MumsNet* (<http://www.mumsnet.com/>) but by putting concerns/symptoms into Google to come up with suggestions as to what to do. There were two characteristic times/reasons to look to the internet; when baby had a problem that they were concerned about, for example if he/she appeared unwell, or when, more generally, they were not sure what to do, perhaps they had heard different views. There was also some sense that the internet was used to find advice that supported things they wanted to do anyway!

Many attend groups for Mothers and toddlers at local venues (not just Children's Centres). They compare their babies, looking at weight now as compared to weight at birth. Discussions are not just a simple comparison of size for age, but of how much a baby has grown. While there was some sense that "chubby babies are healthier" and comparisons can cause concern, sometimes other factors can be reassuring; "he's not bigger than the others... but he's more alert than general babies his age".

Our interviews reinforce the importance of influence of grandmothers, and of aunts – many of our mothers live with extended family. Loads of people, like my mother-in-law, have complained that she has gone right weak, because their babies are more massive than my daughter. Now my mother-in-law is saying, 'give her milk till she gets better', and then I'll start doing baby food."

Family give advice and support but they may also be seen as a problem. Mothers can experience Dads as undermining, "he just sits in front of the TV with them". Likewise Grandparents, "they give the children anything".

1.4.11 Discussion

These qualitative interviews have provided data that is consistent with that previously reported in the literature. Parental perceptions are developed through interactions with a range of sources of influence including family, friends and health professionals. The internet is of increasing prominence as a source of information. There is not a clear hierarchy of influence.

Perceptions and actions are mediated through interaction with the child/baby. They constitute empirical knowledge, learnt from this experience. The empirical knowledge gained from one's own previous children is an important influence.

The idea of an ecosystem, (developed by Bronfenbrenner¹⁴ and supported in reviews of qualitative research) is a useful way to identify the many different zones of influence on family practices regarding infant feeding and attitudes to infant size. The exo-system might define a public problem (say being overweight, or eating

“junk” food) but if this isn’t reinforced by the meso and micro-systems it doesn’t become a personal concern. We have a glimpse that, while there are many shared experiences between White British and Pakistani families, there are different degrees of influence from various parts of the ecosystem that are more salient for the latter. One of these is a chrono-system that is still shaped by experiences of migration and attitudes and practices from the counties of origin. A more widely shared chrono-system idea that bigger (“bonnie”) babies are healthier, and a resistance to seeing rates of weight gain in infancy as a pathology prevents the exo-system breaking through the complex webs of meaning that surround it, and that it surrounds, to effect a change in the person.

1.5 A mealtime observation study: obesity, ethnicity and observed maternal feeding styles

1.5.1 Background

Research is consistent in the finding that infants who have an obese parent are at an increased risk of obesity in childhood and adulthood. It has been reported that parental obesity more than doubles the risk of adult obesity among both obese and non-obese children of less than 10 years of age.⁽¹⁹⁾ More recently, it was reported that having an obese parent increases the likelihood that a child will be obese 4-5 fold.⁽²⁰⁾

While there is a recognised large genetic component to weight variation, the shared family environment is also a potentially important contributor to the heritability of obesity. It is parents who predominantly determine the availability of foods for their children including what, how and when specific foods are available. Parents serve as role models, socializing children to their food choices, eating habits and feeding behaviours, as well as providing examples for attitudes and coping skills and setting standards for perfection and acceptance. Parents are also important determiners of the social contexts in which children eat, including the emotional tone of different eating occasions which will be influenced by general parental styles and family context.

General parenting styles have been summarized as two dimensions comprising control/demandingness and warmth/responsiveness.^(21, 22) These independent dimensions yield four different parenting styles: authoritarian, authoritative, permissive and uninvolved parenting. The applicability of these typologies to non-western groups has been challenged. For example, Chao⁽²³⁾ believes that authoritarian control is not a valid construct when applied to Chinese, and more broadly Asian, parenting. Control and restrictiveness that are characteristic of these families reflect a different set of underlying beliefs than those of European-Americans.

Within western culture, control and strictness tends to have negative connotations and are equated with domination, which may explain the negative outcomes

associated with high parental control. In contrast, within East Asian culture control is reflected in devotion to parents, the importance of education, respect for authority, and emotional restraint.⁽²⁴⁾ It could be argued that parenting typologies originally developed with American samples cannot be translated to other cultures, but instead reflect their socio-cultural contexts and underlying beliefs and ideas. There is certainly an absence of research regarding parenting styles of South Asian families, especially those living in the UK.

International studies regarding ethnicity and feeding practices are similarly limited; Asian populations are rarely included. In contrast, studies of feeding practices relating to parental or child obesity are increasing although it is difficult to determine consistency in outcome.

Observational studies have some advantages over retrospective questionnaire assessments but are more labour intensive and time consuming. Few have been directed at very young children and none have involved non-white families in the UK. Accordingly, the present study aimed to explore the influence of two factors, maternal weight and ethnicity, on mealtime interactions. Specifically, whether the meal structures and mealtime interactions of mothers categorised as obese, and their children, were different to healthy weight mothers; and whether there was a difference between South Asian and non-Asian mothers in the meal structures and mealtime interactions with their children.

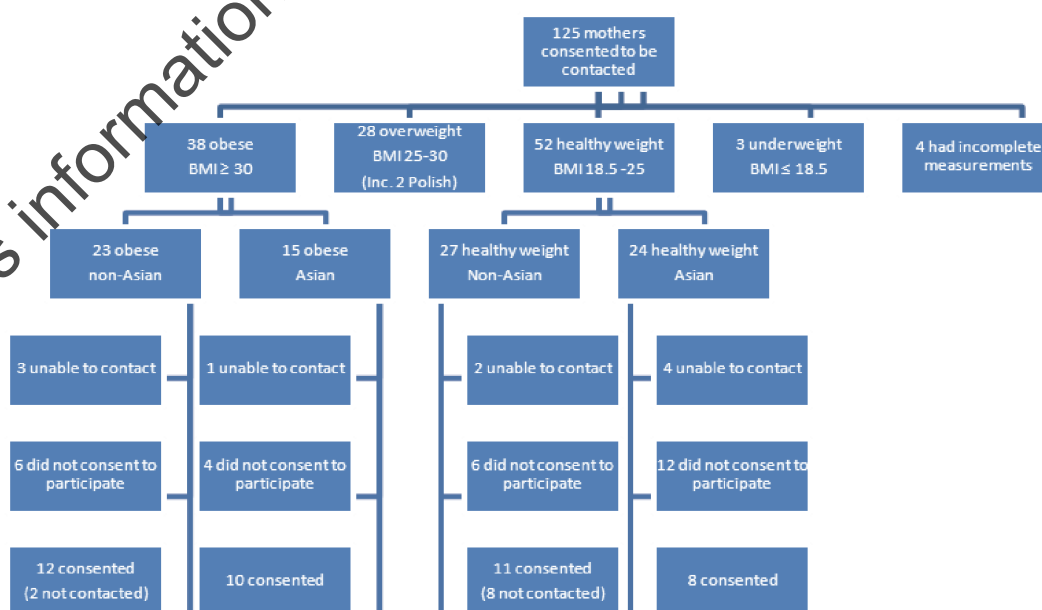
1.5.2 Methods

1.5.2.1 Participants

The present study recruited participants from clinics that BiB1000 mothers attended when their child was both 18-months and 2 years old. Mothers were contacted if they were eligible for the study on the basis of BMI (>30) and ethnicity. The intention was to recruit 40 mother-child dyads.

The participant recruitment flow can be seen in figure 4.

Figure 4: Participant recruitment flow



In total, 38 mothers took part in the study. Six of the South Asian mothers were born in Pakistan (three were obese and three were healthy weight) and one in Iran. Fifteen mothers identified themselves as Pakistani and two as Indian. Of the children there were more boys than girls in the total sample (24 vs 14).

The study was given favourable ethical review by the South Yorkshire Research Ethics Committee.

1.5.2.2 Meal observation

Mothers were asked to prepare an ordinary meal for their child on the day of the observation; neither the child's favourite meal, nor something that they had not tried before or that they disliked. A typical meal was recorded in the participant's home when the child was between 18 and 27 months old. All participants were provided with a copy of the mealtime recording on DVD and thanked, in writing, for participating in the study.

All recorded mealtimes were analysed using the Mealtime Observation Schedule: MOS⁽²⁶⁾, a coding system that originates from the Positive Parenting Program (known as Triple P), a copy of the coding schedule can be found in appendix 2.2. The MOS covers a wide range of parental and child behaviours and can be used without the need for extensive observer training. The length of meal times for each mother-infant dyad was noted. Using the recordings, mothers' and infants' verbal and nonverbal behaviour was coded in 10-second intervals. Behaviour categories were scored for their presence in a particular 10-second interval, but not for the frequency of occurrence. There are sixteen categories of parent behaviour in the MOS (nine positive, six negative and no interaction)⁽²⁵⁾. A further eighteen categories relate specifically to child behaviour (seven positive, eleven negative).

The MOS has a good inter-rater reliability with a mean of 0.83 obtained for parent behaviour (range 0.71 – 0.99) and 0.80 for child behaviour (range = 0.50 – 0.99).⁽²⁶⁾

1.5.2.3 Questionnaires

Parents completed 3 questionnaire assessments when their child was approximately 6, 12 and 24 months old. These were:

The caregivers feeding styles questionnaire, which categorises caregivers into authoritative, authoritarian, indulgent and uninvolved child feeding styles, according to levels of demandingness and responsiveness.⁽²⁷⁾

The parenting practices questionnaire (Growing up in Australia Wave 1) assessing three dimensions: self-efficacy, warmth and hostility.

The infant characteristics questionnaire assessing four factors: adaptability, fussiness/difficultness, dullness and predictability.⁽²⁸⁾

In addition, the following demographic information was available from the BiB database: mother's country of birth, education status, current household structure, home postcode (for index of multiple deprivation 2010, IMD score).

1.5.2.4 Data analysis

Mealtimes where the mother and child spoke in Punjabi or Urdu (or in one case Arabic) were translated before the recordings were analysed. To ensure reliability of coding, two additional raters coded four mealtime recordings each; one selected from each of the participant groups. Two of these recordings were the same and therefore coded by all three raters. Inter-rater reliability was established by computing intra-class correlations. The mean intra-class correlation for three raters was 0.86 and for two raters was 0.83, indicating high levels of agreement.

Two-way between groups Analyses of Variance (with mother's age, child's age and IMD 2010 scores as covariates) tested whether there were differences in the mealtime interactions of obese and healthy weight mothers and the South Asian and non-South Asian mothers.

1.5.3 Results

1.5.3.1 Participant characteristics

Table 15 summarizes the characteristics of the mothers and their children who took part in the study. Overall, the mean age of the mothers was 29yr 8m and the mean age of the children was 1yr 9m. There was no significant difference between the groups in terms of mothers' or children's age, or IMD 2010 scores. There were ten mothers in the sample who were ranked as living in the most deprived decile in England.

Table 15. Mean (SD) and range of final sample characteristics

	South Asian obese (N=10)	South Asian healthy weight (N=8)	Non-South Asian obese (N=10)	Non-South Asian healthy weight (N=10)
Mother's BMI	35.8 (4.9) 30.0 - 45.1	22.9 (2.7) 19.0 - 25.0	34.1 (4.7) 30.2 - 43.7	21.6 (1.4) 18.9 - 23.4
Mother's age (years)	31.7 (5.4) 20 - 38	27.6 (4.6) 21 - 33	31.1 (5.5) 25 - 43	28.8 (6.3) 18 - 39
Child's age (years)	2.0 (0.1) 1.5 - 2.3	1.9 (0.2) 1.6 - 2.1	1.8 (0.3) 1.5 - 2.3	1.7 (0.3) 1.5 - 1.9
IMD Score	36.9 (17.6)	31.1 (9.9)	29.8 (18.0)	39.2 (19.4)
IMD Ranking ^a	23.6 (19.4)	26.3 (13.2)	34.6 (26.6)	25.9 (24.6)

^aAreas are ranked from least deprived to most deprived on seven different dimensions of deprivation and an overall composite measure of multiple deprivation. Higher scores = more deprivation.

1.5.3.2 Organisation and environmental context of the mealtime

In total, six breakfasts, twenty-six lunches and six dinners were recorded. The majority of mothers felt that the recorded mealtime was typical, in that their child's behaviour was not much different to usual. Fifty per cent or more of mealtimes involved the provision of some fruit or vegetables. The mothers in the non-Asian healthy weight group supplied fruit or vegetables most frequently (70%). The number of children who ate their meal with no one else eating at the same time was comparable across all four groups. There was a tendency for non-Asian mothers to seat their child in a high chair or booster seat more than South Asian mothers.

South Asian mothers presented food more times to their child compared to non-Asian mothers ($F(1,31) = 4.15$, $p < 0.05$). There was no effect of weight status or interaction ($F(1,31) = 0.57$, $p = 0.46$). However, the interaction effect was statistically significant. Meal duration showed a significant interaction between maternal weight and ethnicity ($F(1,31) = 7.68$, $p = 0.009$) and was shortest for the children whose mothers were South Asian and healthy weight and longest for the children whose mother was non-Asian and healthy weight. This pattern only occurred in the healthy weight groups. The speed at which the child ate was comparable across all four groups.

1.5.3.3 Positive parent behaviours

Overall, there was significantly less positive mother-child behaviour in the mealtimes of the South Asian mothers compared with the non-Asian mothers ($F(1,31) = 10.91$, $p = 0.002$; Table 16). South Asian mothers also used positive eating comments significantly less frequently than non-Asian mothers ($F(1,31) = 16.16$, $p < 0.001$). They displayed significantly less positive social attention towards their children ($F(1,31) = 6.04$, $p = 0.02$). There was no difference in verbal praise or in positive contact.

The only effect of maternal weight was that obese mothers made more positive comments than normal weight mothers ($F(1,31) = 10.25$, $p = 0.003$). There were no significant interaction effects on any of these measures.

Table 16. Mean (SD) percentage of mealtime intervals that mother's positive behaviours occurred

	South Asian obese (N=10)	South Asian healthy weight (N=8)	Non-South Asian obese (N=10)	Non-South Asian healthy weight (N=10)
Total positive behaviours	75.9 (19.5)	61.4 (20.8)	87.6 (9.5)	89.0 (8.5)
Positive eating comment	23.3 (13.0)	10.3 (8.1)	36.9 (7.0)	25.9 (10.9)
Positive social attention	18.1 (14.5)	23.9 (12.0)	28.7 (9.6)	37.8 (16.3)
Praise	10.5	6.6	7.0	11.5

	(11.7)	(3.9)	(5.1)	(11.6)
Positive	16.5	12.5	4.9	4.6
contact	(30.6)	(10.6)	(3.7)	(2.1)

1.5.3.4 Negative parent behaviours

South Asian mothers displayed significantly more negative parenting during the mealtimes than non-Asian mothers ($F(1,31) = 5.58$, $p=0.03$; Table 17). A main effect for weight status ($F(1,31) = 8.84$, $p=0.01$) indicated that healthy weight mothers showed more negative parenting behaviours than obese mothers. All three covariates were significant in this analysis. There were weak and non-significant negative correlations between negative parenting behaviours and mother's age and deprivation score. There was a significant correlation with child's age ($r(36)=0.387$, $p=0.016$) indicating more negative parenting behaviours in older children.

This information has not been subject to peer review

Table 17. Mean (SD) percentage of mealtime intervals that mother's negative behaviours occurred

	South Asian obese (N=10)	South Asian healthy weight (N=8)	Non-South Asian obese (N=10)	Non-South Asian healthy weight (N=10)
Total negative behaviours	12.4 (12.1)	28.8 (23.4)	7.8 (9.3)	7.3 (8.0)
Negative eating comment	3.0 (3.0)	5.1 (6.1)	4.9 (10.7)	1.7 (3.7)
Negative contact	0.1 (0.3)	3.5 (6.0)	0.0 (0.0)	0.0 (0.0)

1.5.3.5 Positive child behaviours

There were no differences in total positive child behaviour during mealtimes by ethnicity or weight status (Table 18). Children with South Asian mothers did show higher levels of engaged activity ($F(1,31) = 6.83, p=0.01$). But these children took fewer independent self-bites ($F(1,31) = 5.44, p=0.026$) and there were fewer intervals coded as appropriate verbal interactions ($F(1,31) = 8.14, p=0.008$). There were no differences on other measures or of maternal weight.

Table 18. Mean (SD) percentage of mealtime intervals that child's positive behaviours occurred

	South Asian obese (N=10)	South Asian healthy weight (N=8)	Non-South Asian obese (N=10)	Non-South Asian healthy weight (N=10)
Total positive behaviours	71.2 (21.5)	51.6 (29.2)	71.1 (19.3)	80.3 (15.2)
Child's food preparation	10.6 (11.7)	10.5 (10.6)	7.7 (7.0)	15.6 (11.1)
Self bites	14.5 (12.8)	16.0 (17.1)	25.9 (14.4)	32.9 (20.6)
Prompted bites	17.8 (12.5)	12.2 (11.7)	9.3 (8.9)	8.3 (9.2)
Engaged activity	15.2 (13.3)	12.7 (11.9)	10.3 (6.4)	10.0 (5.0)
Appropriate verbal behaviour	6.5 (6.3)	3.9 (5.0)	10.7 (5.4)	10.8 (7.8)

1.5.3.6 Negative child behaviours

Children with South Asian mothers demonstrated marginally greater levels of negative behaviours during mealtimes ($F(1,31) = 4.01, p=0.054$) and there was a

main effect of ethnicity on time away from the table ($F(1,31) = 5.10$, $p = 0.03$; Table 19). The group of children who had healthy weight South Asian mothers showed the greatest frequency of these negative behaviours (as indicated by significant interaction effects). Note that children's age was a significant covariate indicating that older children spent more time away from the table ($r(36) = 0.637$, $p < 0.001$). There were no effects of maternal weight on these measures.

Table 19. Mean (SD) percentage of mealtime intervals that child's negative behaviours occurred

	South Asian obese (N=10)	South Asian healthy weight (N=8)	Non-South Asian obese (N=10)	Non-South Asian healthy weight (N=10)
Total negative behaviours	29.7 (20.5)	48.4 (29.2)	25.9 (12.3)	20.4 (14.6)
Non-compliance	1.8 (1.7)	5.9 (6.8)	2.6 (4.7)	0.7 (1.0)
Leave the table	0.4 (1.4)	22.1 (32.2)	6.1 (13.2)	0.5 (0.9)
Food refusal	8.6 (9.2)	9.2 (4.5)	5.2 (4.0)	5.5 (9.7)

1.5.3.7 Questionnaire measures

Scores on the caregivers feeding style questionnaire showed that obese mothers were significantly less demanding than healthy weight mothers ($F(1,31) = 6.83$, $p = 0.014$). There was no main effect of ethnicity and there were no differences between the groups on reported responsiveness. In terms of overall parenting style obese mothers were most likely to report using indulgent parenting ($N = 13/20$). In contrast, healthy weight mothers were most likely to report using an authoritarian parenting style ($N = 10/18$).

The parenting practices questionnaire showed South Asian mothers to score lower on warmth of parenting than non-South Asian mothers ($F(1,31) = 5.52$, $p = 0.026$). There were no effects of maternal weight or any differences in the measure of hostility.

Finally, analysis of the responses to the infant characteristics questionnaire revealed no group differences.

1.5.4 Discussion

The main aims of the study related to the potential influence of maternal obesity and ethnicity on the mealtimes interactions with young children. The following are the main learning points taken from this study that are considered relevant for an intervention directed at young children's mealtime interactions.

First, there was no evidence of maladaptive parenting in the mealtimes organised by obese mothers. Indeed, they used fewer negative parenting behaviours than healthy weight mothers and used a greater number of positive eating comments

during mealtimes. The children of obese mothers did not behave in a different way to the children of healthy weight mothers.

Second, many more differences were observed between the mealtimes of South Asian mothers and non-South Asian mothers. We found: there were differences in the physical organisation of mealtimes. For example, more of the South Asian mothers did not seat their child in a chair or use a table for their child's mealtime; South Asian mothers made fewer positive eating comments and spent less time during the mealtimes providing positive social attention; South Asian mothers showed a greater number of negative specific instructions than non-South Asian mothers; there were greater levels of negative child behaviour in the children of South Asian mothers; and South Asian mothers presented food to their child a greater number of times during a meal. This is consistent with the observation that their children demonstrated less independent eating. Overall, the results indicate that South Asian mothers exert a different *type* of control during mealtimes with their children by giving a greater number of specific and clear direct instructions. This may be in response to more challenging behaviour of their children.

Third, there were some inconsistencies between self-report and observational measures related to parenting. This may not be surprising given that the questionnaire measures related to overall parenting while the observation focused on a single meal and that the questionnaire refers to when children are 6 months of age and the meal-time observation is when the children are older. However, questionnaire responses showed obese mothers were more likely categorised as indulgent parents and non-obese mothers authoritarian. South Asian mothers scored lower on warmth in their parenting practices.

Fourth, age (but not deprivation) influenced mealtime interactions. For example, younger mothers had more positive physical contact with their children, regardless of weight status or ethnicity. In addition, older children demonstrated increased levels of non-compliance and spent more time away from the meal table.

General discussion and conclusions: investigation of social and environmental determinants of childhood obesity

This section reports on four discreet studies adopting different methodologies, and collecting data from four different groups, to explore the context and circumstances in which food choices are made. In the first study interviews with mothers with small babies revealed the relational nature of a social life within which they were making decisions about infant feeding. They receive advice from many different sources, from within their own family, from friends and neighbours, from a range of professionals and, increasingly, from sources they explore themselves on the Internet. They often experience the information they receive as contradictory. It appears that perceptions about appropriate size for infants and children, and concerns about rates of growth, are linked to parents concerns that their baby/child was "like others" of the same age. While the experience of having a new baby

produces demands that are similar for White and South Asian parents, the configuration of influences they operate within differs.

The rapid rise in the prevalence of childhood obesity has stimulated research on early parent feeding styles. The study of 38 mother-child dyads reported here recorded during a typical mealtime indicates that mothers of different ethnicities, living within the same geographical region, can demonstrate different parenting behaviours when feeding their toddlers. It has also revealed important differences in the frequency of positive and negative parenting strategies within, and between, groups that require further exploration.

The third study kept our focus on the home. Key food and drink items were noted in 100 homes of BiB participants (97 full data sets were collected) with White British and Pakistani families about equally represented in the sample. There did not appear to be a relationship between food availability and maternal weight status but there were differences by ethnicity, for example Pakistani participants had three times the number of sweetened drinks in the home when compared to white families. Key findings included that although the majority of homes have at least 1 type of fruit or vegetable available to them, there was variability in the amount and tinned/frozen fruits and vegetables were less common. Homes of Pakistani mothers tended to have a greater availability of fresh fruits than those of White British mothers; but also had significantly higher amounts of sugar sweetened beverages.

The fourth study shifted the focus from the individual account and the observation of family behaviour to consider the environment in which families are making their choices about food. Is proximity to food outlets which sell food high in saturated fat associated with deprivation, weight status and ethnicity? Food outlets were mapped in specific areas of the city, and linked with information on 1198 women within the Born in Bradford study. There was a strong association between deprivation and fast food outlet density, with poorer areas having higher density; but there was a negative association between BMI and fast food outlet density for South Asians. This study showed the rich data that can be obtained from looking in close detail at what sorts of food are available; but it also highlighted the need to consider how individuals make choices within their neighbourhood.

The results from these studies have the following implications for the development of a childhood obesity prevention intervention:

- 1) Understandings are arrived at, and choices are made, in the context of many interlinked systems of influence. Targeting only one has the potential that any change is undermined by alternative influences. Interventions should target the social nature of choices that impact on obesity and seek to achieve either system wide changes, changes in the immediate systems that surround the individual or enhanced confidence in individual agency on the part of parents. For example an educational intervention would need not only to offer culturally sensitive information in a way that is experienced as authoritative but it ought to be accompanied by enhancing the ability of the parent to make choices. This is more

likely if the intervention could be delivered to a group who could act as a peer support group.

1) Intervention effectiveness will be enhanced if practitioners know which components of parenting to target within a culturally sensitive context. Parenting styles vary according to ethnicity and those practices that might constitute targets for intervention in one group would not be applicable to another, or at least would not be of equal salience. This is an argument for bespoke interventions to impact on parenting styles that reflect ethnic variations.

3) Seeking to change food and drink consumption should focus on: a) promoting availability and quantity of all types of fruits and vegetables (e.g. encouraging purchase of tinned/frozen fruit in addition to fresh fruit); b) reducing purchase of crisps and biscuits (which were both available in over 80% of homes); c) discouraging purchase of sweetened beverages, especially within homes of Pakistani mothers (in which 85% of homes had at least one type of sweetened beverage available; d) promoting the availability of a greater variety of fruits and vegetables.

4) Living in close proximity (500m) to a fast food outlet was commonplace in the Bradford wards that were studied. This degree of proximity was observed in 95% participants. This should be considered when applications for further food outlets are made.

There are some limitations. Each of the four studies focus on children of different ages and so do not build up a composite picture of a particular child's world. While each of the studies refer to a wide literature they do not have a wide range of sources to draw on where the sorts of ethnic background that is characteristic of this study are explored. The qualitative study is relatively small scale and the food outlet study is limited in its geographical range but the mealtime observation study and the food inventory collection is of a size consistent with other studies exploring these areas. While acknowledging the contribution of these studies their limitations point to areas for further study. It is clear that ethnicity needs to be fore-grounded and modifications to prevalent assumptions and to previously tested interventions are required to ensure their appropriateness.

References

1. Geertz C. The Interpretation of Cultures. New York, Basic Books 1973.
2. Buchbinder M, Timmermans S. Newborn screening and maternal diagnosis: rethinking family benefit. *Social science & medicine* (1982). 2011 Oct;73(7):1014-8. PubMed PMID: 21835525. Epub 2011/08/13. eng.
3. Gilman SL. Fat: a cultural history of obesity: Polity Press; 2008.
4. Gilman SL. Obesity: the Biography: Oxford University Press; 2010.
5. Charmaz K. 'Discovering' chronic illness: using grounded theory. *Social science & medicine* (1982). 1990;30(11):1161-72. PubMed PMID: 2360052. Epub 1990/01/01. eng.

6. Pocock M, Trivedi D, Willis W, Bunn F, J. M. Parental perceptions regarding healthy behaviours for preventing overweight and obesity in young children: a systematic review of qualitative studies. *Obesity Reviews*. 2010;11:338-53.
7. Goodell SL, Pierce MB, Bravo CM, Ferris AM. Parental perceptions of overweight during early childhood. *Qualitative health research*. 2008 Nov;18(11):1548-55. PubMed PMID: 18849515. Epub 2008/10/14. eng.
8. Redsell SA, Atkinson P, Nathan D, Siriwardena AN, Swift JA, Glazebrook C. Parents' beliefs about appropriate infant size, growth and feeding behaviour: implications for the prevention of childhood obesity. *BMC public health*. 2010;10:711. PubMed PMID: 21087482. Pubmed Central PMCID: PMC3000404. Epub 2010/11/23. eng.
9. Lucas P, Arai L, Baird J, Kleijnen J, Law C, Roberts H. A systematic review of lay views about infant size and growth. *Archives of disease in childhood*. 2007 Feb;92(2):120-7. PubMed PMID: 16905565. Pubmed Central PMCID: PMC2083310. Epub 2006/08/15. eng.
10. MacArthur C, Jolly K, Ingram L, Freemantle N, Dennis CL, Hamburger R, et al. Antenatal peer support workers and initiation of breast feeding: cluster randomised controlled trial. *BMJ (Clinical research ed)*. 2009;338:b131. PubMed PMID: 19181730. Pubmed Central PMCID: PMC2636685. Epub 2009/02/03. eng.
11. Griffith L. Motherhood, ethnicity and experience: a narrative analysis of the debates concerning culture in the provision of health services for Bangladeshi mothers in East London. *Anthropology & medicine*. 2010 Dec;17(3):289-99. PubMed PMID: 21153963. Epub 2010/12/15. eng.
12. Atkin K. Approaches to conducting qualitative research in ethnically diverse populations. In, *Primary healthcare and South Asian populations: Meeting the challenges*. Buckingham: Open University Press; 2004.
13. Ahmad WIU. *Race and health in contemporary Britain*. Buckingham: Open University Press; 1993.
14. Bronfenbrenner U. *The Ecology of Human Development: Experiments by Nature and by Design*. Cambridge MA: Harvard University Press; 1979.
15. Bronfenbrenner U. Ecology of the family as a context for human development: research perspectives. *Developmental Psychology*. 1986;22(6):723-42.
16. Infant & Toddler Forum. *Infant and Toddler Forum 2010. Ten steps for healthy toddlers*. 2010 Contract No.: 13 August 2013.
17. Wright J, Small N, Raynor P, Tuffnell D, Bhopal R, Cameron N, et al. Cohort profile: The Born in Bradford multi-ethnic family cohort study. *International journal of epidemiology*. 2012;Published online doi: 10.1093/ije/dys112.
18. Reissman CK. *Narrative analysis*. Sage. 1993.
19. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *The New England journal of medicine*. 1997 Sep 25;337(13):869-73. PubMed PMID: 9302300.
20. Daniels SR, Arnett DK, Eckel RH, Gidding SS, Hayman LL, Kumanyika S, et al. Prevention and treatment of overweight in children and adolescents: pathophysiology, consequences, prevention, and treatment. *Circulation*. 2005 Apr 19;111(15):1999-2012. PubMed PMID: 15837955. Epub 2005/04/20. eng.
21. Baumrind D. Current patterns of parental authority. *Developmental Psychology Monographs*. 1971;4:1-103.

22. Maccoby EE, Martin JA. Socialization in the context of the family: parent-child interaction. In Hetherington EM, ed. *Handbook of Child Psychology: Socialization, Personality, and Social Development*. 4th ed. New York: NY: Wiley; 1-101; 1983.
23. Chao RK. Beyond parental control and authoritarian parenting style: understanding Chinese parenting through the cultural notion of training. *Child development*. 1994 Aug;65(4):1111-9. PubMed PMID: 7956468. Epub 1994/08/01. eng.
24. Van Campen KS, Russell ST. Cultural differences in parenting practices: What Asian American families can teach us (Vol. 2, No. 1) Tucson, AZ: The University of Arizona: Frances McClelland Institute for Children, Youth, and Families Research Link, 2010.
25. Wilson SL. A Mealtime Observation Study: obesity, ethnicity and observed maternal feeding styles. Presented for the Degree of D ClinPsychol, School of Medicine University of Leeds; 2011. Available from: http://etheses.whiterose.ac.uk/1739/1/Mealtime_Observation_Study_22nd_Sept_2011.pdf
26. Sanders MR, Le Grice B, Turner KMT. Mealtime observation schedule: An observer's manual (Rev.ed.). Unpublished technical manual. Behavior Research and Therapy Centre, University of Queensland 1993.
27. Cullen KW, Baranowski T, Rittenberry L, Cosart C, Hebert D, de Moor C. Child-reported family and peer influences on fruit, juice and vegetable consumption: reliability and validity of measures. *Health education research*. 2001 Apr;16(2):187-200. PubMed PMID: 11345661. Epub 2001/05/11. eng.
28. Downs SM, Arnold A, Marshall D, McCargar L, Baine KD, Willows ND. Associations among the food environment, diet quality and weight status in Cree children in Quebec. *Public Health Nutr*. 2009 Sep;12(9):1504-11. PubMed PMID: 19144239. Epub 2009/01/16. eng.

This information has not been subject to peer review

Appendix 2 Further details of data collection instruments

2.1: Interview schedule (social and environmental determinants of childhood obesity)

Ask about how baby's development is going, is baby feeding and growing as she thought he/she should.

Ask about what goes on in a typical day in relation to baby's feeding (if they say they can't think of a typical day ask them to talk about yesterday).

Breastfeeding

Was baby ever breastfed?

- If no: prompt – what made you decide not to breastfeed?
- Is baby still being breastfed?
 - Does baby get anything else other than breast milk?
- How old was baby when you stopped giving just breast milk?
 - What made you decide to stop just breastfeeding?

Feeding/weaning

- What did/do you give baby? (details of food and drink)
- How often/what amounts?
- How did you decide what to give and how often and how much to give?
- How has what is given changed as baby has got older?
- Do you cook and prepare baby's food yourself or buy pre-prepared food? (prompt for details of what is cooked and what is bought)

Other topics

1. How has the experience of baby been in relation to feeding?
2. Has baby been 'easy' or difficult? [if they have had another child ask how this baby was compared with the previous one(s)]
3. Can you describe mealtimes in your house:
 - Prompt: Eat at same times? Sit with family when eat?
 - Does family eat together?
 - Eat food prepared yourself or prepared food?
 - Do different family members eat different foods?
4. Who does the food shopping in your family?
 - Who decides what you will eat on any day?
 - Who does the cooking?
 - Does the regular shopper/cooker also buy and prepare baby's food?

5. Is baby regularly looked after by someone else, either when you are at work or for any other reason?
If yes then ask:

- Who looks after baby, where?
- Do they feed baby – if yes, what do they give baby (food and drink), how often and how much (this includes being looked after in the family home by extended family members)? Do you decide what baby gets to eat when he/she is away from you or do they?

6. Are you happy with how baby has been growing?

- Has baby been healthy or 'sickly' – does baby sleep well?
- Do you think baby looks the right size for age (e.g. compared with others of the same age or with any previous children you have had)?

7. What do you think are the important things that need to happen to keep baby healthy (e.g. eating well, growing, sleeping well, somewhere warm and safe to be, lots of care and attention)?

8. If you are not sure what to do with baby or if you are worried about something who do you go to for advice (e.g. family members, friends, other mums, health professionals)?

9. Who do you think influences you when you are making decisions about bringing up baby?
How strongly do they influence you? – you can choose as many as you like from this list.

	Strong influence	An influence
Baby's father		
Your mother		
Others in your family		
Baby's father's mother		
Others in baby's father's family		
Your friends		
Other mums you know		
Health professionals (list them)		
Children's centre staff		
Other professionals (list them)		
Things you read in papers/magazines/books		
Things you hear on the radio or see on TV or the internet		
Others (please list them)		

10. Has there been one person in particular who has been a particular help/support with baby? If yes, who? (don't need a name – just title, e.g. mother, health visitor).

Interviewer: Take some field notes just after you leave the house – that is, record details of where the interview took place, who was there (was baby there), what the room and the house and the street were like, whether there were toys around. How confident did you feel that mum was being open with you?

2.2: Mealtime observation schedule coding scheme

BOX 1 Coding categories for parent behaviours

Positive parent behaviours

- Praise.
- Contact.
- Specific instruction.
- Vague instruction.
- Prompt.
- Eating comment.
- Presentation of food.
- Removal of food.
- Social attention.

Negative parent behaviours

- Aversive contact.
- Aversive specific instruction.
- Aversive vague instruction.
- Aversive prompt.
- Aversive eating comment.
- Aversive social attention.

Source: Sanders MR, Le Grice B, Turner KMT. *Mealtime Observation Schedule: an Observer's Manual* (rev. ed.). Unpublished technical manual. Brisbane: Behavior Research and Therapy Centre, University of Queensland; 1993.

BOX 2 Coding categories for infant behaviours**Positive child behaviours**

- Request for food.
- Food preparation.
- Self-bite.
- Prompted bite.
- Chew.
- Appropriate verbal interaction.
- Engaged activity.

Aversive child behaviours

- Food refusal.
- Vomit.
- Playing with food.
- Leaving the table.
- Holding food.
- Non-compliance.
- Complaint.
- Aversive demand.
- Negative physical behaviours.
- Oppositional behaviour.
- Non-interaction.

Source: Sanders MR, Le Grice B, Turner KMT. *Mealtime Observation Schedule: an Observer's Manual* (rev. ed.). Unpublished technical manual. Brisbane: Behavior Research and Therapy Centre, University of Queensland; 1993.

2.3: Home food availability inventory***Foods in your home***

Please tell us whether you have had any of the following foods or drinks in your home *over the past 7 days*. Estimate the amount of food based on the *greatest* amount that you had in your home in that period.

Use the pictures on the guidance sheet to help you work out the sizes.

Tips for filling out this form:

- Individual fruits are single pieces (e.g. one apple, one banana).
- Individual tomatoes refer to regular-sized tomatoes. If you have cherry tomatoes, count each one as two.
- A medium can of coke has 330 ml of coke.
- One handful of crisps is about the same amount as a regular individual-sized bag of crisps.
- Half a handful of salted nuts is about the same amount as a small individual-sized bag of peanuts.

There are also tips at the bottom of the table to help you decide how much you have of each item.

Remember: There are no wrong or right answers.

Food/drink	Description	Size	Amount			
Fruits						
1. Bananas	Fresh	Individual	0	1–3	4–10	> 10
2. Apples	Fresh	Individual	0	1–3	4–10	> 10
3. Melon	Fresh	Whole melon	0	1/2	1	> 1
4. Grapes	Fresh	Handful	0	1–3	4–10	> 10
5. Oranges	Fresh	Individual	0	1–3	4–10	> 10
6. Pears	Fresh	Individual	0	1–3	4–10	> 10
7. Peaches	Fresh	Individual	0	1–3	4–10	> 10
8. Canned fruit in syrup	Any fruit	Medium-sized can	0	1 can	2–5	> 5
9. Canned fruit in juice/water	Any fruit	Medium-sized can	0	1 can	2–5	> 5
10. Plums	Fresh	Individual	0	1–3	4–10	> 10
11. Kiwis	Fresh	Individual	0	1–3	4–10	> 10
12. Pineapple	Fresh	Whole pineapple	0	1/2	1	> 1
13. Berries or cherries (including strawberries)	Fresh or frozen	Handful	0	1	2	> 2
14. Grapefruit	Fresh	Whole grapefruit	0	1/2	1–3	> 3
15. Fruit salad	Fresh	Cup/handful	0	1–3	4–10	> 10
16. Dried fruit	(e.g. raisins, apricots)	Cup/handful	0	1	2	> 2
Vegetables						
17. Carrots	Fresh or frozen	Individual	0	1–3	4–10	> 10
18. Celery	Fresh	Individual stick	0	1–3	4–10	> 10
19. Greens/spinach	Fresh or frozen	Cup/handful	0	1	2	> 2
20. Lettuce	Fresh	Individual head or mixed bag	0	1	2	> 2
21. Sweet maize	Fresh or frozen	Cup/handful	0	1	2	> 2
22. Peas	Fresh or frozen	Cup/handful	0	1	2	> 2
23. Tomatoes	Fresh	Individual	0	1–3	4–10	> 10
24. Tomatoes	Canned	Medium can	0	1	2–5	> 5
25. Broccoli	Fresh or frozen	Florets/head	0	1–3	4–10	> 10
26. Green beans	Fresh or frozen	Cup/handful	0	1	2	> 2
27. Cabbage	Fresh	Whole cabbage	0	1/2	1	> 1
28. Other vegetables including aubergine, okra, etc.	Fresh	Cup/handful	0	1/2	1	> 1
29. Canned vegetables	Any vegetable	Medium-sized can	0	1 can	2–5	> 5

Food/drink	Description	Size	Amount			
Snacks						
30. Crisps, tortilla chips	All varieties	Handful	0	1–3	4–10	> 10
31. Salted nuts	Including peanuts	Handful	0	½ – 3	4–10	> 10
32. Biscuits	All varieties	Medium-sized pack	0	1–15	16–30	> 30
33. Sweets	Hard and soft	Handful	0	1	2–5	> 5
34. Chocolate	All varieties	Medium-sized bar or handful	0	1	2–5	> 5
35. Cakes, muffins	All varieties	Medium portion	0	1–3	4–10	> 10
36. Ice cream	All varieties	Medium tub	0	1	2	> 2
Drinks						
37. Fizzy drink (e.g. cola)	Not diet	Medium can/bottle	0	1–5	6–10	> 10
38. Fizzy drink (e.g. diet cola)	Diet	Medium can/bottle	0	1–5	6–10	> 10
39. Sports drink	All varieties	Medium bottle	0	1–5	6–10	> 10
40. Fruit drinks	Not 100% fresh	Medium can/bottle	0	1–5	6–10	> 10

Appendix 3 Full texts of publications that are not open access

The reliability of routine anthropometric data collected by health workers: a cross-sectional study

Reprinted from *Int J Nurs Stud*, vol. 46, Johnson W, Cameron N, Dickson P, Emsley S, Raynor P, Seymour C, Wright J. The reliability of routine anthropometric data collected by health workers: a cross-sectional study 2009,⁷⁰ with permission from Elsevier.



Available online at www.sciencedirect.com



International Journal of Nursing Studies 46 (2009) 310–316

INTERNATIONAL JOURNAL OF
**NURSING
STUDIES**

www.elsevier.com/ijns

The reliability of routine anthropometric data collected by health workers: A cross-sectional study

William Johnson^{a,*}, Noël Cameron^a, Peter Dickson^b,
Stuart Emsley^{b,c}, Pauline Raynor^c, Claire Seymour^b, John Wright^c

^a Centre for Human Development and Ageing, Loughborough University, UK

^b Bradford and Airedale Teaching Primary Care Trust, Douglas Mill, UK

^c Bradford Institute for Health Research, Bradford Royal Infirmary, UK

Received 4 June 2008; received in revised form 6 October 2008; accepted 6 October 2008

Abstract

Background: Reliable data on child growth is a prerequisite for monitoring and improving child health. Despite the extensive resources invested in recording anthropometry, there has been little research into the reliability of these data. If these measurements are unreliable growth may be misreported, and health problems may go undetected.

Objectives: To assess the reliability of routine infant growth data, following anthropometric training of health workers responsible for collecting these data, in Bradford, UK. To determine whether being observed by an external administrator influenced reliability.

Design: A test–retest design was used.

Participants: All health workers ($n = 192$) responsible for growth monitoring in Bradford were included in the study, of which 36.5% ($n = 70$) had complete data.

Methods: Following training in basic anthropometry all health workers were asked to complete a test–retest study, using infants aged 0–2 years. Health workers took two recordings of weight, length, head circumference, and abdominal circumferences on five infants. A peer health worker recorded a third set of measurements on each infant. Twenty-two individuals were selected to be observed by an external administrator during data collection. Technical error of measurements (TEMs) were produced to assess intra-observer and inter-observer reliability. Differences between groups were tested to determine whether external observation influences reliability.

Results: None of the TEMs were excessively large, and coefficients of reliability ranged from 0.96 to 1.00. All intra-observer and inter-observer TEMs for the observed group were larger than those for the non-observed group. For example, the observed group's intra-observer TEMs for weight, length, abdominal circumference, and head circumference (46.18 g, 0.60 cm, 0.65 cm, 0.47 cm) were larger than the non-observed group's TEMs (9.14 g, 0.35 cm, 0.34 cm, 0.19 cm). TEMs for weight, abdominal circumference, and head circumference were significantly larger for the observed group, compared to the non-observed group ($p < 0.001$). Inter-observer TEMs for length were also significantly larger for the observed group ($p = 0.031$), whilst intra-observer TEMs for length were not significantly different between the two groups ($p = 0.137$).

Conclusions: Following training in anthropometry health workers in Bradford can, in general, reliably measure child growth. TEMs were comparable to data from other research studies and all coefficients of reliability were indicative of good quality control. Reliability measurement provides a method of quality assurance for routine data monitoring. If commissioners of health

* Corresponding author. Tel.: +44 1509 228 159.

E-mail address: W.O.Johnson@lboro.ac.uk (W. Johnson).

services are to be informed by these data then some form of reliability assessment should be considered, and if employed external observation is recommended to improve validity.

© 2008 Elsevier Ltd. All rights reserved.

Keywords: External observation; Growth monitoring; Quality assurance; Reliability; Technical error of measurement

What is already known about the topic?

- Extensive resources are invested in recording anthropometry in the UK for the purposes of growth monitoring.
- Large measurement error can influence interpretation, and in this setting may result in health problems going undetected.

What this paper adds

- Age specific TEMs from routine growth data, after initial training of health workers responsible for data collection, are comparable to those from other research projects, and should be deemed reliable.
- There is a significant difference between TEMs from health workers who self-reported reliability data and those who were observed.

1. Introduction

The growth rate of an individual is an important indicator of general health (Cameron, 2007), and growth monitoring is therefore an important screening tool. Health professionals accept growth monitoring as a standard component of community paediatric services throughout the world (Hall, 1996). Monthly growth monitoring of all children under 18 months of age is recommended in developing countries (UNICEF, 1990), and protocols with less frequent measuring are endorsed in developed countries. In the UK, growth monitoring is a standard component of child health services in the UK (Department of Health and Social Security, 1974), which involves children being regularly measured, these data being plotted on growth reference charts, and where growth is unfavourable, referral to an appropriate specialist (Garner et al., 2000). Growth monitoring distinguishes between those who demonstrate favourable growth and those who do not.

Growth monitoring has become increasingly important in the light of the epidemic of childhood obesity, which has been described as one of the most daunting public health threats facing developed countries (Department of Health, 2003). In the UK there was a statistically significant increase in body mass index (BMI) of children under 4 years of age between 1989 and 1998 (Bundred et al., 2001). Overweight and obesity are risk factors for insulin resistance and the development of the vascular and metabolic dysfunctions that precede overt cardiovascular disease and Type II diabetes (Cooper-Dehoff and Pepine, 2007). Monitoring for unfavourable growth patterns during infancy may be an important component of intervention programmes to target those at risk for obesity and non-communicable diseases later in life (Summerbell et al., 2005).

The use of Personal Child Health Records (PCHR) is endorsed in the National Service Framework for Children (Department of Health, 2004), and since 1991 PCHRs have been issued to all mothers in the UK (Wright and Reynolds, 2006). The record was developed to improve communication, enhance continuity of care, and increase parental understanding of their child's health and development (Hall and Elliman, 2003). Retention rates for the PCHR have been reported to be high throughout the UK (Hall and Elliman, 2003). Walton et al. (2006) reported that 93% ($n = 15,733$) of mothers, enrolled in the Millennium Cohort Study, were able to produce their PCHR when asked to by an interviewer. One main purpose of the PCHR is to provide an impetus for monitoring growth during infancy. The PCHR contains tables and charts which allow measurements of weight, length, and head circumference to be recorded throughout infancy. A national standard PCHR has been designed (Royal College of Paediatrics and Child Health, 2004), although each PCT has the choice to include pages that allow the recording of measurements before 28 days of age, at 6–8 weeks, and at 7–9 months. Therefore, there is no national growth monitoring program throughout the UK. Measurement of all children at the three defined age periods is generally recognised as routine practice, and most Primary Care Trusts (PCTs) including Bradford and Airedale PCT follow this measurement schedule (Patterson et al., 2006).

Over 90% of PCTs use health visitors to collect growth data for the PCHRs (Patterson et al., 2006), although staff nurses, community nursery nurses, and student health visitors also aid data collection. In general, staff nurses will have undergone 3 years of training to receive either a bachelors degree, an advanced diploma, or a registered general nurse qualification; and community nursery nurses will have either a BTEC National Diploma in Child Studies, or an NNEB (nursery nurse qualification) or equivalent. While health visitors will have studied for either a bachelors or postgraduate degree, and will be registered on the Nursing and Midwifery Council. Hereafter the term 'health worker' will be used to describe all professionals responsible for growth monitoring. The utility of the data health workers collect is dependent on its reliability. However, despite the extensive resources invested in recording growth measurements in the UK, there has been little research into reliability. This paper

reports the results of a study to investigate the reliability of routine growth data as part of a cohort study.

Born in Bradford is a longitudinal birth cohort study that will investigate the determinants of childhood and adult disease. Twenty-five percent of Bradford's total population of 380,000 people are of South Asian origin. Half of the estimated 6000 annual births at Bradford Royal Infirmary (BRI) are to South Asian parents. A high proportion of these babies live in the most deprived areas of Bradford, as measured by the Index of Multiple Deprivation for England and Wales (Bradford Health Informatics Service, 2008), and associations between multiple deprivation and infant mortality in Bradford have been made (Macfarlane, 2008). In 2002, the city's infant mortality rate of 9.1 was significantly larger than the English and Welsh combined value of 5.3 (Bradford and District Infant Mortality Commission, 2005). Bradford provides the study with a unique multi-ethnic population that is characterised by high rates of infant and childhood morbidity. Growth monitoring in Bradford is fundamental to the early identification of health abnormalities, although the process of growth monitoring is not unique to Bradford. Health workers throughout the UK collect routine growth data during infancy. The initial phase of Born in Bradford aims to utilise growth data from routine health assessments. Measuring the magnitude of measurement error will help determine if these data are reliable, and is a major element of quality control (Goto and Mascie-Taylor, 2007). If these data are to be used, either for scientific purposes or to inform health service policies and recommendations, reliability must be quantified.

2. Aims

To assess the reliability of routine infant growth data for weight, height, head circumference, and abdominal circumference, following initial training of health workers responsible for collecting these data, in Bradford. To determine whether being observed by an external administrator during data collection influenced health worker's reliability.

3. Methods

All Community Practice Teachers (CPTs) and one health worker from each health centre in Bradford were invited to attend a growth-training workshop (CPTs are senior health visitors who train student health visitors during their community placement and mentor newly qualified staff). These workshops, organised by Born in Bradford in collaboration with the Child Growth Foundation, provided training on how to reliably measure weight, length, head circumference, and abdominal circumference. Supporting measurement protocols were also produced and disseminated. Health workers who attended these sessions then organised their own training days

where all information was made available for their peers. At least one member of the Born in Bradford team attended all health centre training days.

Following training, all health workers in Bradford were asked to complete a test–retest reliability study. This involved taking anthropometric measurements on five infants aged less than 2 years. Discussions with Bradford and Airedale teaching Primary Care Trust (tPCT) concluded that health workers could feasibly collect data on a maximum of five infants. Each infant had three sets of measurements recorded, two by the health worker and the third by a peer health worker. Each health worker was provided with a form on which to record these data.

Measurements included weight, length, abdominal circumference, and head circumference. Infants were weighed naked, and to the last completed 10 g, using Seca baby scales. If an infant became restless weight was ascertained by measuring mother and infant together, and then subtracting the mother's weight. Length was measured to the last completed 0.5 cm using a standard issue neonatometer (Harlow Health Care, London, UK). Health workers had the choice between three pieces of equipment (Harlow Health Care, London, UK) to measure head and abdominal circumferences, all of which measured to a precision of 0.1 cm. Lassos were provided to record head circumference and abdominal circumference. Some health workers had a preference for more traditional tape measures, and these data were included in analyses.

One health worker from each health centre was randomly selected to be observed by a study administrator when collecting their data. A study administrator organised to visit these selected health workers at baby clinics, which all health centres in Bradford hold weekly (baby clinics are sessions where mothers can seek the advice of health workers, and have their babies measured and immunised). The study administrator was instructed to simply observe health workers whilst they collected their test–retest data. The study administrator ensured that each health worker understood what was asked of them, but apart from this had no other contact with the health worker during data collection. Following data collection any questions regarding the study were answered. Forms were returned by hand or via post to the study administrator, and could be divided between two groups of health workers, observed and non-observed.

The resulting data were used to produce technical error of measurements (TEMs). The TEM is the standard deviation of differences between repeated measures, uncorrelated for bias (Mueller and Martorell, 1988). In practice, this means that 95% of repeat results will fall within $\pm 1.96 \times \text{TEM}$. In the test–retest study the differences between the first two measurements were used to produce individual intra-observer TEMs for each measurement. Similarly, the differences between the first and third measurements were used to calculate health workers inter-observer TEMs. Therefore,

Table 1
Intra-observer technical error of measurements (TEMs).

	Weight (g)	Length (cm)	Abdominal circumference (cm)	Head circumference (cm)
Total (70)				
Mean TEM	20.78	0.43	0.44	0.28
Standard deviation	50.28	0.55	0.30	0.32
Coefficient of reliability	1.00	1.00	0.99	0.99
Observed (22)				
Mean TEM	46.18	0.60	0.65	0.47
Standard deviation	72.20	0.89	0.31	0.46
Coefficient of reliability	1.00	1.00	0.97	0.98
Non-observed (48)				
Mean TEM	9.14	0.35	0.34	0.19
Standard deviation	30.69	0.26	0.25	0.16
Coefficient of reliability	1.00	1.00	1.00	1.00

for each health worker there were eight TEMs, four intra-observer and four inter-observer. Mean TEMs were calculated for the observed and non-observed groups, and for the whole sample (see Tables 1 and 2). The majority of variables were not normally distributed, and demonstrated significant positive skewing. Therefore, Mann–Whitney tests were performed to check for statistical significance between observed and non-observed data (see Tables 3 and 4).

Ethical approval for the study was granted by Bradford Research Ethics Committee, and research governance approval was provided by Bradford NHS Teaching Hospitals Trust and Bradford and Airedale PCT.

4. Results

Of the 192 health workers in Bradford 44.3% ($n = 85$) returned forms and 36.5% ($n = 70$) of these had complete data. Twenty-two health workers were observed during data collection, and 48 were not.

None of the TEMs were excessively large, and coefficients of reliability ranged from 0.96 to 1.00 (see Tables 1 and 2). Measurement error was generally higher for abdominal circumference, followed by length, and then head circumference. For example, the mean intra-observer TEM for all health workers was 0.44 cm for abdominal

Table 2
Inter-observer technical error of measurements (TEMs).

	Weight (g)	Length (cm)	Abdominal circumference (cm)	Head circumference (cm)
Total (70)				
Mean TEM	21.19	0.56	0.61	0.37
Standard deviation	50.11	0.35	0.35	0.28
Coefficient of reliability	1.00	1.00	0.98	0.99
Observed (22)				
Mean TEM	43.24	0.66	0.81	0.60
Standard deviation	72.82	0.29	0.31	0.28
Coefficient of reliability	1.00	0.99	0.96	0.97
Non-observed (48)				
Mean TEM	11.08	0.51	0.52	0.27
Standard deviation	31.39	0.37	0.32	0.21
Coefficient of reliability	1.00	1.00	0.99	1.00

Table 3
Mann–Whitney test for Intra-observer TEM data.

	Weight (g)	Length (cm)	Abdominal circumference (cm)	Head circumference (cm)
Observed (22): Median TEM (range)	14.49 (233.78)	0.37 (4.43)	0.62 (1.35)	0.33 (2.16)
Non-observed (48): Median TEM (range)	0.00 (208.71)	0.32 (1.30)	0.30 (1.13)	0.16 (0.72)
Mann–Whitney U	184.5	411.0	204.0	192.0
p value	<0.001**	0.137	<0.001**	<0.001**

** Significant at alpha 1% level.

Table 4

Mann–Whitney test for Inter-observer TEM data.

	Weight (g)	Length (cm)	Abdominal circumference (cm)	Head circumference (cm)
Observed (22): Median TEM (range)	9.85 (229.26)	0.67 (1.33)	0.88 (1.18)	0.51 (1.21)
Non-observed (48): Median TEM (range)	0.00 (208.71)	0.46 (1.86)	0.49 (1.45)	0.21 (1.25)
Mann–Whitney U	253.50	358.00	264.50	101.50
<i>p</i> value	<0.001**	0.031*	0.001**	<0.001**

* Significant at alpha 5% level.

** Significant at alpha 1% level.

circumference, compared to 0.28 cm for head circumference. In practice this means that 95% of repeat measures for abdominal circumference and head circumference will fall within ± 0.86 cm and ± 0.55 cm, respectively (i.e. $1.96 \times$ TEM). All inter-observer TEMs, apart from weight in the observed group, were larger than the respective intra-observer TEMs. Measurement error was larger in the observed group, and this is reflected by larger TEMs. For example, the observed group's intra-observer TEMs for weight, length, abdominal circumference, and head circumference (46.18 g, 0.60 cm, 0.65 cm, 0.47 cm) were larger than the non-observed group's TEMs (9.14 g, 0.35 cm, 0.34 cm, 0.19 cm). This pattern was present for both intra-observer and inter-observer data.

There were significant differences between the observed and the non-observed groups' TEMs (see Tables 3 and 4). Generally, measurement error was significantly higher in the observed group, compared to the non-observed group. Intra-observer TEMs for weight, abdominal circumference, and head circumference were significantly larger for the observed group, compared to TEMs for the non-observed group ($p < 0.001$). Intra-observer TEMs for length were not significantly different between the two groups ($p = 0.137$). Similarly, all inter-observer TEMs were significantly larger for the observed group at alpha 1% ($p < 0.001$), apart from length which was significantly larger at alpha 5% ($p = 0.031$).

5. Discussion

After training in basic anthropometry, TEMs from health workers in Bradford were comparable to published TEMs from research studies that reported acceptable levels of reliability (Ulijaszek and Kerr, 1999). A general conclusion that health workers can reliably measure child growth can be made. However, health workers who were observed by a study administrator during data collection had higher levels of measurement error than those who were not observed.

All health workers responsible for growth monitoring in the community were included in the study, making the total sample externally valid. Only 36.5% of health workers returned forms with complete data. However, we have no reason to believe that these individuals differed in any way from the total health worker population (e.g. sex, level of

education attained, and duration of employment as a health worker). Complete data was collected on health workers from different geographical locations across Bradford. Our sample does not, therefore, neglect health workers who monitor growth in areas of Bradford which have important defining characteristics. For example, areas with high levels of deprivation, or areas that are predominantly occupied by South Asian populations. For these reasons we believe our total sample is representative of all health workers in Bradford. The study administrator aimed to observe one health worker from each health centre although time constraints did not allow this. Individuals in the observed group were selected at random and were likely to be representative of health workers with varying levels of enthusiasm to participate in the study. Whereas, it is likely that only the most enthusiastic health workers returned forms in the non-observed group. There may, therefore, be selection bias in the non-observed group. If the reliability of all health workers was routinely assessed data from the less enthusiastic individuals could be collected.

A paucity of research reporting age-specific TEMs meant that power calculations could not be performed. Whilst our total sample is representative of health workers in Bradford, a larger sample size would have further increased the power to detect statistically significant differences in TEMs. This study only assessed the reliability of health workers in Bradford, and no comparable age-specific TEMs from health workers in other cities or counties have been published. It is important to reiterate that health workers and their involvement in growth monitoring are not unique to Bradford. Health workers with similar levels of education, training, and experience measure infant growth at routine age periods in other cities and counties, and for this reason we would expect similar levels of reliability throughout the UK.

The large number of health workers in health services responsible for collecting anthropometric data increases the likelihood that one person's measurements will differ significantly from another's (Ulijaszek and Kerr, 1999). The difference between repeat measurements has been termed measurement error, and in this context has been used to explain the extent to which repeat measures give the same value (Habicht et al., 1979). Large measurement error can influence interpretation and limit the usefulness of growth data (Ulijaszek and Kerr, 1999). Growth monitoring is used to assess the growth of an individual

between two, or more time points, and thus depends on a series of recordings. Small measurement error for any one recording is unlikely to have clinical significance, but systematic measurement error for two or more recordings will decrease the ability of growth monitoring to identify failure to thrive. The measurement error of routine growth data has clinical importance which, in part, determines the validity of growth monitoring.

The TEM is the statistic most commonly used to explain measurement error (Mueller and Martorell, 1988), and can provide sufficient information to determine whether a set of anthropometric measurements are reliable. The coefficient of reliability (r) reveals what proportion of variance is free from measurement error. Coefficients of reliability above 0.95 are indicative of good quality control (Goto and Mascie-Taylor, 2007).

The TEMs from this study are similar to acceptable levels of reliability found in anthropometric literature, and all coefficients of reliability were above 0.95. For these reasons, our TEMs indicate good reliability of growth measures. Compared to the mean TEMs reported in Uliaszek and Kerr's (1999) review our TEMs for weight and abdominal circumference were smaller. This is surprising considering that Uliaszek and Kerr conducted a review of research studies, where data was collected by trained anthropometrists. Our intra-observer TEM for length (0.43 cm) was within the range (0.10–0.80 cm) reported in Uliaszek and Kerr's (1999) review, and our inter-observer TEM for length (0.56 cm) was just outside the range (0.1–0.5 cm). Compared against reliability data (WHO Multicentre Growth Reference Study Group, 2006), on anthropometrists trained to measure infants in the WHO Multicentre Growth Reference Study (MGRS), our TEMs for length and head circumference were similar.

The mean TEMs reported in Uliaszek and Kerr's (1999) review included results from data on infants, children, and adults. As the absolute measurement increases it is likely that absolute measurement error also increases. It could, therefore, be assumed that TEMs from data on adults would be larger than TEMs from data on infants. This may be why our TEMs for weight and abdominal circumference are smaller than those reported by Uliaszek and Kerr. There may be a need for age specific TEMs. However, it is unlikely that the magnitude of the measurement will affect reliability within our age range (0–2 years). The MGRS have reported age specific TEMs for infants aged 0–24 h, and another set for infants aged 0–1 years (WHO Multicentre Growth Reference Study Group, 2006). Our TEMs for length and head circumference are comparable with these data. Other studies have reported age specific (1–2 years) intra-observer and inter-observer TEMs for length of 0.4 and 0.5 cm, respectively (Uliaszek, unpublished; Pelletier et al., 1991). Our mean TEMs for all health workers were almost identical to these data (0.43 and 0.56 cm). We are not aware of published age specific TEMs for weight and abdominal circumference during infancy.

In general, the inter-observer TEMs from this study were marginally larger than the intra-observer TEMs. It might also be expected that the difference between two recordings taken by the same person should be smaller than the difference if two people took one recording each. However, it is far from universally the case that intra-observers TEMs are smaller than inter-observer TEMs (Uliaszek and Lourie, 1994). Using data from the Malawi Maternal and Child Health Survey, Pelletier et al. (1991) found intra-observer error to be greater than inter-observer error for length and arm circumference. Larger intra-observer errors have also been reported for subscapular skinfolds in a United States population (Johnston et al., 1972).

The observed group's TEMs were, in general, significantly larger than the non-observed group's. There are a number of possible reasons for this. Firstly, the presence of an observer distracted or intimidated health workers resulting in larger TEMs. Secondly, health workers in the non-observed group felt like they were being judged and reported more favourable results to appear more reliable. Throughout the study health workers were assured that variability is an inherent part of the measurement process. However, health workers had never been asked to complete a reliability study before and may have felt expectations to report high reliability. Health workers in the non-observed group were more likely to report both their first and second recording, for a measurement, to be the same. There were also more occurrences in the non-observed data where all three recordings were the same. Also, health workers in the non-observed group reported head and abdominal circumferences to the nearest 0.5 cm more frequently than health workers in the observed group. If this is because of rounding results up/down health workers in the non-observed group did not measure to the full precision of the instruments. For these reasons we believe that self-reported reliability checks may produce favourable results, hence TEMs for the non-observed group should be interpreted with caution. The results of this study should be used to emphasise the normal variation expected between repeat measurements in future documentation and training of anthropometry.

TEMs from routine growth data collected by health workers in Bradford indicate acceptable levels of measurement error. TEMs were calculated from data collected by health workers, after they had been trained in basic anthropometry. This was, in effect, an intervention study, and reliability after training is acceptable. Training in anthropometry and the production of a measurement protocol may have helped to standardise measurement technique of health workers in Bradford, improving reliability. Although, without test–retest data available prior to training this hypothesis cannot be tested.

Extensive resources are invested in collecting and recording growth measurements in developed and developing countries throughout the world. In the UK, there has been no research into the reliability of these measurements. Routine growth monitoring produces an unexploited source

of data for public health surveillance, and our results suggest that with initial training in measurement techniques these data can be of research calibre.

Health care commissioners require accurate growth data if they are going to make evidence based decisions on local policy and provision of services. Reliability checks, including external observation, of intra-observer and inter-observer error should be considered to measure the accuracy of growth data. As well as measuring accuracy, reliability checks reinforce the importance of standards and act as a quality assurance mechanism with feedback to practitioners.

Acknowledgements

This research was generously supported by the Child Growth Foundation and could not have been completed without the time and co-operation of the health visitors of Bradford who have our gratitude.

Conflicts of interest

None.

Funding

Child Growth Foundation.

Ethical approval

Ethical approval for the study was granted by Bradford Research Ethics Committee (07/Q1202/38), and research governance approval was provided by Bradford NHS Teaching Hospitals Trust and Bradford and Airedale PCT.

References

- Bradford and District Infant Mortality Commission, 2005. Interim Report on Progress.
- Bradford Health Informatics Service, 2008. Analysis and Interpretation of Infant Mortality Data. Available: www.bdimc.bradford.nhs.uk (accessed on 05.06.2008).
- Bundred, P., Kitchiner, D., Buchan, I., 2001. Prevalence of overweight and obese children between 1989 and 1998: population based series of cross sectional studies. *British Medical Journal* 322 (7282), 326–328.
- Cameron, N., 2007. Growth patterns in adverse environments. *American Journal of Human Biology* 19 (5), 615–621.
- Cooper-Dehoff, R.M., Pepine, C.J., 2007. Metabolic syndrome and cardiovascular disease: challenges and opportunities. *Clinical Cardiology* 30 (12), 593–597.
- Department of Health, 2003. Annual Report of the Chief Medical Officer 2002. Health Check: On the State of the Public Health. Department of Health Publications, London.
- Department of Health, 2004. Care Document, National Service Framework for Children, Young People and Maternity Services. Department of Health Publications, London.
- Department of Health and Social Security, 1974. Present Day Practice in Infant Feeding. HMSO, London.
- Garner, P., Panpanich, R., Logan, S., 2000. Is routine growth monitoring effective? A systematic review of trials. *Archives of Disease in Childhood* 82 (3), 197–201.
- Goto, R., Mascie-Taylor, C.G., 2007. Precision of measurement as a component of human variation. *Journal of Physiological Anthropology* 26 (2), 253–256.
- Habicht, J.P., Yarbrough, C., Martorell, R., 1979. Anthropometric field methods: criteria for selection. In: Jelliffe, D.B., Jelliffe, E.F.B. (Eds.), *Nutrition and Growth*. Plenum Press, New York, pp. 365–387.
- Hall, D.M.B., 1996. Health for All Children. Report on the Third Joint Working Party on Child Health Surveillance. Oxford University Press, Oxford.
- Hall, D.M.B., Elliman, D., 2003. Health for All Children, 4th ed. Oxford University Press, New York.
- Johnston, F.E., Hamill, P.V., Lemeshow, S., 1972. Skinfold thickness of children 6–11 years, United States. *Vital and Health Statistics. Series 11, Data from the National Health Survey* 120(120), 1–60.
- Macfarlane, A., 2008. Trends and Variations in Births and Infant Mortality in England and Wales. Available: www.bdimc.bradford.nhs.uk (accessed on 05.06.2008).
- Mueller, W.H., Martorell, R., 1988. Reliability and accuracy of measurement. In: Lohman, T.G., Roche, A.F., Martorell, R. (Eds.), *Anthropometric Standardisation Reference Manual*. Human Kinetics Books, Illinois, pp. 83–86.
- Patterson, L., Jarvis, P., Verma, A., Harrison, R., Buchan, I., 2006. Measuring children and monitoring obesity: surveys of English primary care trusts 2004–2006. *Journal of Public Health* 28 (4), 330–336.
- Pelletier, D.L., Low, J.W., Msukwa, L.A.H., 1991. Sources of measurement variation in child anthropometry in the Malawi maternal and child nutrition survey. *American Journal of Human Biology* 3, 227–237.
- Royal College of Paediatrics and Child Health, 2004. The National Standard PCHR. Available: <http://www.health-for-all-children.co.uk/?SHOP=HFAC4&DO=USERPAGE&PAGE=PCHRPDF> (accessed on 13.08.2008).
- Summerbell, C.D., Waters, E., Edmunds, L.D., Kelly, S., Brown, T., Campbell, K.J., 2005. Interventions for Preventing Obesity in Children. *Cochrane Database of Systematic Reviews (Online)* 3(3), CD001871.
- Ulijaszek, S.J., Unpublished data.
- Ulijaszek, S.J., Kerr, D.A., 1999. Anthropometric measurement error and the assessment of nutritional status. *The British Journal of Nutrition* 82 (3), 165–177.
- Ulijaszek, S.J., Lourie, J.A., 1994. Intra- and inter-observer error in anthropometric measurement. In: Ulijaszek, S.J., Mascie-Taylor, C.G.N. (Eds.), *Anthropometry: The Individual and the Population*. Cambridge University Press, Cambridge, pp. 30–56.
- UNICEF, 1990. Strategy for Improved Nutrition of Children and Women in Developing Countries. United Nations Children's Fund, New York.
- Walton, S., Bedford, H., Dezateux, C., Millennium Cohort Study Child Health Group, 2006. Use of personal child health records in the UK: findings from the millennium cohort study. *British Medical Journal* 332 (7536), 269–270.
- WHO Multicentre Growth Reference Study Group, 2006. Reliability of anthropometric measurements in the WHO Multicentre Growth Reference Study. *Acta Paediatrica* 450, 38–46.
- Wright, C.M., Reynolds, L., 2006. How widely are personal child health records used and are they effective health education tools? A comparison of two records. *Child: Care, Health and Development* 32 (1), 55–61.

Ethnic differences in the initiation and duration of breast feeding – results from the Born in Bradford birth cohort study

Reproduced with permission from Santorelli G, Petherick E, Waiblinger D, Cabieses B, Fairley L. Ethnic differences in the initiation and duration of breast feeding – results from the Born in Bradford birth cohort study. *Paediatr Perinat Epidemiol* 2013;**27**:388–92.⁸² © John Wiley & Sons Ltd.

Paediatric and Perinatal Epidemiology

Affiliated to the Society for Pediatric and Perinatal Epidemiologic Research

doi: 10.1111/ppe.12052

Ethnic Differences in the Initiation and Duration of Breast Feeding – Results from the Born in Bradford Birth Cohort Study

Gillian Santorelli, Emily Petherick, Dagmar Waiblinger, Baltica Cabieses, Lesley Fairley

Bradford Institute for Health Research, Temple Bank House, Bradford Royal Infirmary, Duckworth Lane, Bradford, UK

Abstract

Background: Initiation of breast feeding and duration of any breast feeding are known to differ by ethnic group, but there are limited data on differences in exclusive breast feeding. This study aimed to determine if there are ethnic differences in the initiation and duration of any and exclusive breast feeding.

Methods: Breast-feeding data were obtained from a subsample of 1365 women recruited to a multi-ethnic cohort study (Born in Bradford) between August 2008 and March 2009. Poisson regression was used to investigate the impact of socio-economic, life style and birth factors on ethnic differences in the prevalence of breast feeding.

Results: Compared with white British mothers, initiation of breast feeding was significantly higher in all ethnic groups and this persisted after adjustment for socio-economic, life style and birth factors [Pakistani: prevalence rate ratio (PRR) = 1.19 (95% confidence interval 1.10, 1.29); Other South Asian: PRR = 1.29 (1.18, 1.42); Other ethnicities: PRR = 1.33 (1.21, 1.46)]. There were no differences in exclusive breast feeding at 4 months [Pakistani: PRR = 0.77 (0.54, 1.09); Other South Asian: PRR = 1.55 (0.99, 2.43); Other ethnicities: PRR = 1.50 (0.88, 2.56)]. Any breast feeding at 4 months was significantly higher in mothers of all non-white British ethnicities [Pakistani: PRR = 1.27 (1.02, 1.58); Other South Asian: PRR = 1.99 (1.52, 2.62); Other ethnicities: 2.45 (1.86, 3.21)].

Conclusions: Whilst women of ethnic minority groups were significantly more likely to initiate breast feeding and continue any breast feeding for 4 months compared with white British women, the rates of exclusive breast feeding at 4 months were not significantly different once socio-economic, life style and birth factors were accounted for.

Keywords: breast feeding, ethnicity, cohort study, socio-economic.

Breast feeding is associated with a range of health benefits for mother and child,^{1–3} which is reflected in current recommendations that babies should be exclusively breast fed for the first 6 months of their lives.^{4,5} In the UK, breast-feeding initiation rates have increased over the past decade from 69% in 2000 to 81% in 2010.⁶ However, the prevalence of any breast feeding declines rapidly in the first 2 months and exclusive breast feeding declines even more rapidly; recent data show that by 6 weeks of age, only 50% of babies received any breast milk and just 22% were exclusively breast fed.⁷

A disadvantaged socio-economic background is negatively associated with the initiation and duration of breast feeding.^{8–13} However, in Western societies, mothers from ethnic minority groups, despite gener-

ally being more socio-economically disadvantaged, tend to have higher rates of breast feeding compared with white women.^{8–10,14–17} There is, however, heterogeneity within ethnic groups: in the UK South Asian population, the incidence of breast feeding is highest in Bangladeshi mothers, with rates in Indians and Pakistanis being around 5% and 10% lower respectively.^{8,9}

The aim of this study is to investigate the relationship between initiation, and duration of any and exclusive breast feeding with ethnicity, after adjusting for socio-economic, life style and birth factors.

Methods

Study design

Born in Bradford (BiB) is a longitudinal multi-ethnic birth cohort study aiming to examine the impact of environmental, psychological and genetic factors on maternal and child health and well-being.¹⁸ Bradford is a city in the north of England with high levels of

Correspondence:

Gillian Santorelli, Born in Bradford, Bradford Institute for Health Research, Bradford Teaching Hospitals NHS Foundation Trust, Bradford Royal Infirmary, Duckworth Lane, Bradford BD9 6RJ, UK.

E-mail: gillian.santorelli@bthft.nhs.uk

Ethnic differences in the initiation and duration of breast feeding

socio-economic deprivation and ethnic diversity. Women were recruited at the Bradford Royal Infirmary at 26–28 weeks gestation. Those who consented completed a baseline questionnaire. The full BiB cohort recruited 12 453 women between 2007 and 2010. Ethical approval for the data collection was granted by Bradford Research Ethics Committee. A subsample of the BiB cohort recruited between August 2008 and March 2009 that completed a baseline questionnaire were invited to participate in more detailed follow up at around 6, 12, 18 and 24 months post-partum (BiB 1000, $n = 1735$). Participants were excluded from the analysis if they had multiple births ($n = 28$), had not given birth at Bradford Royal Infirmary ($n = 18$) or had missing breast-feeding ($n = 250$) or covariate ($n = 74$) data. One thousand three hundred and sixty-five singleton infants for whom we have breast-feeding data in either the 6- or 12-month post-partum questionnaire were included in these analyses.

Breast feeding

Initiation was defined as breast feeding for at least 1 day. Exclusive breast feeding was defined as the infant receiving breast milk with no other liquids (including water) or solids, and any breast feeding as the infant receiving breast milk with or without formula, other drinks or solids.⁵ We assessed continuation of exclusive and any breast feeding to 4 months of age, as previously recommended by World Health Organization (WHO).¹⁹

Ethnicity

Ethnicity was self-assigned by the mother at the baseline questionnaire using the same ethnic group classification as the 2001 UK census²⁰ and categorised into white British, Pakistani, Other South Asian (Indian, Bangladeshi and Other South Asian) and Other ethnicities (white other, Black, mixed race, other unspecified).

Covariates

We examined covariates identified as potentially influencing the initiation and duration of breast feeding.^{5,6,12,21–25} Socio-economic factors: mother's age, maternal education and marital status (obtained from baseline questionnaire); life style factors: maternal body mass index (BMI) and smoking during

pregnancy (from maternity records and baseline questionnaire) and birth factors: parity, gestational age, birthweight and mode of delivery (from maternity records).

Statistical analysis

Chi-squared tests were used to assess overall differences in breast feeding stratified by ethnicity. We used Poisson regression with robust variance estimates to investigate the relationship between ethnicity and breast-feeding outcomes. The unadjusted model examined the relationship between breast feeding and ethnicity, with white British mothers as the reference category. A multivariable model adjusted for the covariates described earlier. We estimated missing maternal BMI in 114 (12%) cases using 50 imputed datasets. Sensitivity analyses conducted on a restricted dataset which excluded cases with missing maternal BMI data ($n = 1251$) showed a similar pattern to the findings in the imputed dataset. We present results from imputed models only. Goodness of fit testing confirmed that the Poisson distribution was appropriate for these analyses. Two-tailed P -values of less than 0.05 were considered to be significant. We present prevalence rate ratios (PRR) with 95% confidence intervals. All statistical analyses were conducted using STATA/IC version 11.2 (StataCorp LP, College Station, Texas, USA).²⁶

Results

Table 1 shows the characteristics of the study sample stratified by ethnicity.

Initiating breast feeding

Overall, 75.5% of mothers initiated breast feeding, with significant differences observed between ethnic groups (white British 64.6%, Pakistani 79.9%, Other South Asian 91.7%, Other ethnicities 90.6%, $P < 0.001$). In the unadjusted model, initiation was significantly higher in Pakistani [PRR = 1.24 (1.15, 1.33)], Other South Asian [PRR = 1.42 (1.30, 1.55)] and Other ethnicities [PRR = 1.40 (1.28, 1.33)] compared with white British mothers. This relationship was attenuated in the adjusted model but all differences remained statistically significant (Table 2).

Exclusive breast feeding at 4 months

Overall, only 11% of babies were exclusively breast fed by 4 months of age. However, the rates in women

Table 1. Characteristics of the study population by ethnicity. Values are *n* (%) unless otherwise specified

	All <i>n</i> = 1365	White British <i>n</i> = 526 (38.5%)	Pakistani <i>n</i> = 658 (48.2%)	Other South Asian ^a <i>n</i> = 96 (7.0%)	Other ^b <i>n</i> = 85 (6.2%)
Maternal age					
Mean (SD)	27.3 (5.6)	26.8 (6.2)	27.6 (5.1)	29.3 (5.1)	27.5 (6.2)
Education					
<5 GCSE equivalent	298 (21.8)	102 (19.4)	169 (25.7)	16 (16.7)	11 (12.9)
≥5 GCSEs equivalent	451 (33.0)	197 (37.5)	214 (32.5)	21 (21.9)	19 (22.4)
A-level equivalent	193 (14.1)	85 (16.2)	79 (12.0)	15 (15.6)	14 (16.5)
>A-level equivalent	345 (25.3)	104 (19.8)	177 (26.9)	37 (38.5)	27 (31.8)
Foreign unknown/other	78 (5.7)	38 (7.2)	19 (2.9)	7 (7.3)	14 (16.5)
Marital status					
Married/cohabiting	1178 (86.3)	396 (75.3)	623 (94.7)	93 (96.9)	66 (77.7)
Single/not cohabiting	187 (13.7)	130 (24.7)	35 (5.3)	3 (3.1)	19 (22.4)
Smoked during pregnancy					
Yes	217 (15.9)	172 (32.7)	23 (3.5)	3 (3.1)	19 (22.4)
BMI					
Mean (SD)	25.9 (5.8)	26.8 (6.2)	25.3 (5.4)	26.0 (6.2)	25.0 (4.8)
Missing	114 (8.4)	48 (9.1)	48 (7.3)	7 (7.3)	11 (12.9)
Parity					
Primiparous	531 (38.9)	252 (47.9)	201 (30.6)	36 (37.5)	42 (49.4)
Multiparous	834 (61.1)	274 (52.1)	457 (69.4)	60 (62.5)	43 (50.6)
Gestation					
<37 weeks	71 (5.2)	31 (5.9)	32 (4.9)	4 (4.2)	4 (4.7)
Weight at birth					
<2500 g	104 (7.6)	35 (6.7)	56 (8.5)	9 (9.4)	4 (4.7)
Mode of delivery					
Vaginal	1077 (78.9)	406 (77.2)	535 (81.3)	73 (76.0)	63 (74.1)
Caesarean section	288 (21.1)	120 (22.8)	123 (18.7)	23 (24.0)	22 (25.9)

^aIndian = 57, Bangladeshi = 31 and other = 8.^bWhite other = 23, mixed white and Black = 12, mixed white and South Asian = 6, Black = 24, Other = 20.

GCSE, General Certificate of Secondary Education; SD, standard deviation.

of Other South Asian (22.9%) and Other ethnicities (18.8%) were double that of white British and Pakistani women (both 9.9%, $P < 0.001$). In the unadjusted model, rates were comparable in white British and Pakistani mothers [PRR = 1.00 (0.71, 1.41)] although a lower rate was seen in Pakistani's in the adjusted model [PRR = 0.77 (0.54, 1.09)]. The PRRs in Other South Asian and Other ethnicities were significantly higher in the unadjusted model [PRR = 2.32 (1.48, 3.63) and PRR = 1.90 (1.14, 3.18) respectively], but these differences were accounted for after adjustment for covariates (Table 2).

Any breast feeding at 4 months

By 4 months of age, 28% of infants were receiving any breast milk. The highest prevalence was in Other ethnicities (54.1%), followed by Other South Asian (51.0%), Pakistani (28.7%) and white British (18.6%)

mothers ($P < 0.001$). In the unadjusted model, the PRRs were higher in all ethnic groups compared with white British mothers [Pakistani PRR = 1.54 (1.24, 1.91), Other South Asian PRR = 2.74 (2.10, 3.57) and Other ethnicities PRR = 2.90 (2.23, 3.79)]. This association was attenuated in all ethnic groups in the adjusted model, but remained statistically significant (Table 2).

Comment

Compared with white British mothers, we found that mothers of all other ethnic groups examined were significantly more likely to initiate breast feeding and continue any breast feeding until 4 months of age, which is consistent with previously reported findings from the UK.^{9,27} However, we found no significant differences in the rates of exclusive breast feeding at 4 months by ethnicity after adjustment for covariates. To our knowledge, this is the first time that rates of

Ethnic differences in the initiation and duration of breast feeding

Table 2. Unadjusted and adjusted prevalence rate ratios (PRR) with 95% confidence intervals (95% CI) for breast-feeding outcomes

	<i>n</i> (%)	Unadjusted PRR [95% CI]	Adjusted PRR [95% CI] ^a
Initiating breast feeding			
White British (Reference)	340 (64.6)	1.00	1.00
Pakistani	526 (79.9)	1.24 [1.15, 1.33]	1.19 [1.10, 1.29]
Other South Asian	88 (91.7)	1.42 [1.30, 1.55]	1.29 [1.18, 1.42]
Other ethnicities	77 (90.6)	1.40 [1.28, 1.54]	1.33 [1.21, 1.46]
Exclusive breast feeding at 4 months			
White British (Reference)	52 (9.9)	1.00	1.00
Pakistani	65 (9.9)	1.00 [0.71, 1.41]	0.77 [0.54, 1.09]
Other South Asian	22 (22.9)	2.32 [1.48, 3.63]	1.55 [0.99, 2.43]
Other ethnicities	16 (18.8)	1.90 [1.14, 3.18]	1.50 [0.88, 2.56]
Any breast feeding at 4 months			
White British (Reference)	98 (18.6)	1.00	1.00
Pakistani	189 (28.7)	1.54 [1.24, 1.91]	1.27 [1.02, 1.58]
Other South Asian	49 (51.0)	2.74 [2.10, 3.57]	1.99 [1.52, 2.62]
Other ethnicities	46 (54.1)	2.90 [2.23, 3.79]	2.45 [1.86, 3.21]

^aModel adjusted for maternal age, educational level, marital status, maternal smoking during pregnancy, BMI (at booking; imputed in 114 cases), parity, gestational age, birthweight and mode of delivery.

exclusive breast feeding in a large sample size of Pakistani women in the UK have been reported. We also found that overall rates for breast-feeding initiation were 10% higher in the BiB 1000 cohort than routinely available data for Bradford,²⁸ possibly due to the BiB 1000 cohort having higher prevalence of South Asian, primiparous and older women, – all of which are known to have higher breast-feeding rates.^{6,9} – compared with the maternal population of Bradford as a whole.

A potential limitation of the study is that breast-feeding data were self-reported; however, previous studies have shown this to be a valid and reliable measure.²⁹ Due to small numbers, we had to combine mothers of Other South Asian and Other ethnicities into two overarching categories, and it is acknowledged that the small numbers of mothers and the heterogeneity of ethnic background in these categories mean that these results may not be generalisable to other populations with different ethnic group distributions. In addition, there are likely to be other social factors that influence breast-feeding rates that we have not accounted for, such as income, occupation/returning to work, family support and sociocultural norms that are likely to have influenced the results for women of all ethnic groups.

In summary, this study shows that breast-feeding patterns vary by ethnicity, and thus the importance of

accounting for ethnicity when describing breast-feeding rates. Health professionals must be made aware that despite higher rates of breast-feeding initiation and continuation to 4 months in minority ethnic groups, there is no evidence that they will continue to exclusively breast feed by the time their babies are 4 months of age.

Acknowledgements

We are grateful to all the families who took part in this study, to the midwives for their help in recruiting them, the paediatricians and health visitors and to the Born in Bradford team which included interviewers, data managers, laboratory staff, clerical workers, research scientists, volunteers and managers.

Funding statement

This paper presents independent research commissioned by the National Institute for Health Research Collaboration for Applied Health Research and Care (NIHR CLAHRC) and the Programme Grants for Applied Research funding scheme (RP-PG-0407–10044). The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health.

G. Santorelli et al.

Reference

- 1 Ip S, Chung M, Raman G, Chew P, Magula N, DeVine D, *et al.* Breastfeeding and maternal and infant health outcomes in developed countries. *Evidence report/technology assessment (Full Rep)* 2007; 1–186.
- 2 Kramer MS, Kakuma R. Optimal duration of exclusive breastfeeding. *Cochrane Database of Systematic Reviews* 2002; (4)CD003517.
- 3 Van Rossum CB, Hoekstra J. Quantification of health effects of breastfeeding – review of the literature and model simulation. In: 2005.
- 4 Department of Health. Infant Feeding Recommendation. 2003.
- 5 World Health Organization. *Indicators for Assessing Breastfeeding Practices*. Geneva: World Health Organization, 1991.
- 6 The NHS Information Centre/IFF Research. Infant Feeding Survey 2010: early Results. 2010.
- 7 Bolling K, Grant C, Hamly B, Thornton A. *Infant Feeding Survey 2005*. London: The Information Centre, 2007.
- 8 Thomas M, Avery V. *Infant Feeding in Asian Families*. London: The Stationary Office, 1997.
- 9 Griffiths LJ, Tate AR, Dezateux C. The contribution of parental and community ethnicity to breastfeeding practices: evidence from the Millennium Cohort Study. *International Journal of Epidemiology* 2005; 34:1378–1386.
- 10 Celi AC, Rich-Edwards JW, Richardson MK, Kleinman KP, Gillman MW. Immigration, race/ethnicity, and social and economic factors as predictors of breastfeeding initiation. *Archives of Pediatrics and Adolescent Medicine* 2005; 159:255–260.
- 11 Kelly YJ, Watt RG. Breast-feeding initiation and exclusive duration at 6 months by social class—results from the Millennium Cohort Study. *Public Health Nutrition* 2005; 8:417–421.
- 12 Wright CM, Parkinson K, Scott J. Breast-feeding in a UK urban context: who breast-feeds, for how long and does it matter? *Public Health Nutrition* 2006; 9:686–691.
- 13 Li R, Grummer-Strawn L. Racial and ethnic disparities in breastfeeding among United States infants: third National Health and Nutrition Examination Survey, 1988–1994. *Birth* 2002; 29:251–257.
- 14 van Rossem L, Vogel I, Steegers EA, Moll HA, Jaddoe VW, Hofman A, *et al.* Breastfeeding patterns among ethnic minorities: the Generation R Study. *Journal of Epidemiology and Community Health* 2010; 64:1080–1085.
- 15 Kelly YJ, Watt RG, Nazroo JY. Racial/ethnic differences in breastfeeding initiation and continuation in the United kingdom and comparison with findings in the United States. *Pediatrics* 2006; 118:1428–1435.
- 16 Gibson-Davis CM, Brooks-Gunn J. Couples' immigration status and ethnicity as determinants of breastfeeding. *American Journal of Public Health* 2006; 96:641–646.
- 17 Singh GK, Kogan MD, Dee DL. Nativity/immigrant status, race/ethnicity, and socioeconomic determinants of breastfeeding initiation and duration in the United States, 2003. *Pediatrics* 2007; 119 (Suppl 1):S38–S46.
- 18 Wright J, Small N, Raynor P, Tuffnell D, Bhopal R, Cameron N, *et al.* Cohort profile: the Born in Bradford multi-ethnic family cohort study. *International Journal of Epidemiology* 2012; first published online October 12, 2012 doi:10.1093/ije/dys112.
- 19 Michaelsen KF, Weaver L, Branca F, Robertson A. *Feeding and Nutrition of Infants and Young Children: Guidelines for the WHO European Region, with Emphasis on the Former Soviet Countries*. Copenhagen: World Health Organization, 2000.
- 20 Office for National Statistics. *Ethnic Group Statistics: A Guide for the Collection and Classification of Ethnicity Data*. London: The Stationary Office, 2003.
- 21 Agboado G, Michel E, Jackson E, Verma A. Factors associated with breastfeeding cessation in nursing mothers in a peer support programme in Eastern Lancashire. *BMC Pediatrics* 2010; 10:3.
- 22 Haggkvist AP, Brantsaeter AL, Grijbovski AM, Helsing E, Meltzer HM, Haugen M. Prevalence of breast-feeding in the Norwegian Mother and Child Cohort Study and health service-related correlates of cessation of full breast-feeding. *Public Health Nutrition* 2010; 13:2076–2086.
- 23 Li R, Jewell S, Grummer-Strawn L. Maternal obesity and breast-feeding practices. *The American Journal of Clinical Nutrition* 2003; 77:931–936.
- 24 Scott JA, Binns CW, Oddy WH, Graham KI. Predictors of breastfeeding duration: evidence from a cohort study. *Pediatrics* 2006; 117:646–655.
- 25 Weiser TM, Lin M, Garikapaty V, Feyerharm RW, Bensyl DM, Zhu BP. Association of maternal smoking status with breastfeeding practices: missouri, 2005. *Pediatrics* 2009; 124:1603–1610.
- 26 StataCorp. *Stata Statistical Software: Release 11*. College Station, TX: StataCorp LP, 2009.
- 27 Hawkins SS, Lamb K, Cole TJ, Law C. Influence of moving to the UK on maternal health behaviours: prospective cohort study. *BMJ (Clinical Research Ed.)* 2008; 336:1052–1055.
- 28 NHS/City of Bradford Metropolitan Council. A Breastfeeding Strategy for Bradford District. 2010.
- 29 Li R, Scanlon KS, Serdula MK. The validity and reliability of maternal recall of breastfeeding practice. *Nutrition Reviews* 2005; 63:103–110.

Self-reported maternal parenting style and confidence and infant temperament in a multi-ethnic community: results from the Born in Bradford cohort

Prady SL, Kiernan K, Fairley L, Wilson S, Wright J. Self-reported maternal parenting style and confidence and infant temperament in a multi-ethnic community: results from the Born in Bradford cohort. *J Child Health Care* 2013;**18**:31–46.⁸³ Reproduced with permission from SAGE.

Article



Self-reported maternal parenting style and confidence and infant temperament in a multi-ethnic community: Results from the Born in Bradford cohort

Journal of Child Health Care
2014, Vol. 18(1) 31–46
© The Author(s) 2013
Reprints and permission:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/1367493512473855
chc.sagepub.com

Stephanie L Prady

Department of Health Sciences, University of York, UK

Kathleen Kiernan

Department of Social Policy and Social Work, University of York, UK

Lesley Fairley

Bradford Institute for Health Research, Bradford Teaching Hospitals NHS Foundation Trust, UK

Sarah Wilson

Therapeutic Social Work Team, Leeds Community Healthcare NHS Trust, UK

John Wright

Bradford Institute for Health Research, Bradford Teaching Hospitals NHS Foundation Trust, UK

Abstract

Ethnic minority children in the United Kingdom often experience health disadvantage. Parenting influences children's current and future health, but little is known about whether parenting behaviours and mother's perception of her infant vary by ethnicity. Using the Born in Bradford (BiB) birth cohort, which is located in an ethnically diverse and economically deprived UK city, we conducted a cross-sectional analysis of mother's self-reported parenting confidence, self-efficacy, hostility and warmth, and infant temperament at six months of age. We examined responses from women of Pakistani ($N = 554$) and White British ($N = 439$) origin. Pakistani mothers reported feeling more confident about their abilities as a parent. Significantly fewer Pakistani women adopted a hostile approach to parenting, an effect that was attenuated after adjustment

Corresponding author:

Stephanie L Prady, Department of Health Sciences, Seebohm Rowntree Building Area 4, University of York, Heslington, York YO10 5DD, UK.

Email: stephanie.prady@york.ac.uk

for socioeconomic status and mental health. Overall, women with more self-efficacious, warm and less hostile parenting styles reported significantly fewer problems with their infant's temperaments. Of women with higher self-efficacy parenting styles, Pakistani mothers were significantly more likely than White British mothers to report more problematic infant temperaments, although absolute differences were small. It is unlikely that the ethnic variation seen in children's cognitive and behavioural outcomes in childhood is attributable to differences in parenting or infant characteristics reported at six months.

Keywords

Ethnic minority, infant temperament, parenting confidence, parenting self-efficacy, parenting style

Introduction

In the last available census (2001), 8% of the UK's population was from ethnic minority groups (Lupton and Power, 2004), which is projected to rise to 21% by 2051 (Wohland et al., 2010). In 2001, the largest ethnic minority groups were Indian (23% of ethnic minorities) and Pakistani (16%) (Lupton and Power, 2004). The structural nature of inequality for ethnic minority groups in the United Kingdom and the United States and its impact on health are well documented (Nazroo, 2003), and this is evident in the outcomes of even young children (Flores and The Committee on Pediatric Research, 2010). Ethnic minority children in the United Kingdom may have worse cognitive scores than white children at ages three and five (Dearden and Sibieta, 2010; Kelly et al., 2006). Parents of children of Pakistani origin also report more behavioural problems (Dearden and Sibieta, 2010), which are indicative of poor mental health (Stansfeld et al., 2011; Goodman et al., 2010), although other studies using child-reported outcomes (Maynard and Harding, 2010) and measures from parents, teachers, children and clinical raters (Meltzer et al., 2000) report less risk of mental health problems in this group. This could be explained by sampling variation and different informants contributing complementary but varying information to reports of child behaviour (Meltzer et al., 2000); however, it is not obvious why reporting might vary by ethnicity. While poorer behavioural outcomes were partly explained by the worse socio-economic and child environment experienced by UK ethnic minorities, some variation remains (Dearden and Sibieta, 2010). As parenting is known to exert a significant influence on the future capabilities of children (National Research Council, 2000), a potential source of this variation may be differences in parenting.

The effect of parenting style, the behaviours and attitudes that set the emotional climate of parent-child interactions (Siegler et al., 2006) on children's mental health and well-being are well documented. An indulgent style, characterised by low control and high warmth, is associated with impulsivity and aggressive behaviour (Baumrind, 1991; Maccoby and Martin, 1983) and authoritarian parenting (high control and low warmth) with mental health difficulties, low self-confidence and esteem, decreased emotional maturity, and inadequate behavioural inhibition and self-regulation (Baumrind et al., 2010; Berg-Nielsen et al., 2002; Bradshaw and Hazan, 2006; Coie and Dodge, 1998; Siegler et al., 2006). These behavioural difficulties mature into an increased risk of adolescent and adult depression, anxiety and antisocial psychopathologies at great personal, societal and health care costs (Cummings and Davies, 1994). Hostile parenting practices (aggression and coercive parenting) increase the risk of emotional or conduct disorder as well as relationship and school difficulties (Landy and Tam, 1998). Data from an Australian cohort indicate that three parenting dimensions of global self-efficacy, warmth and hostility independently predict

child health and physical development, social and emotional functioning, and academic competency (Australian Institute of Family Studies, 2006). Effects were visible both in the study's infant cohort (0–1 years) and in the child cohort (4–5 years). In this large population sample, somewhat subtle variations in degrees of warmth and hostility occurring within the 'normal' range of parenting behaviours were potent predictors of children's outcomes (Australian Institute of Family Studies, 2006).

Not only does the style, practice and quality of parenting make a difference to child outcomes, but children's behaviour, more specifically temperament (reactivity and self-regulation; Rothbart, 1981), can also affect how parents behave towards their children. The more 'difficult' a child is perceived to be temperamentally, the lower the degree of maternal responsiveness (Milliones, 1978). Infants described as having easy temperaments experience a different pattern of interaction with their parents than infants perceived as difficult to manage (Putnam *et al.*, 2002; Van den Bloom *et al.*, 1994). The reciprocity within parent–infant dyads is likely to be affected by how a child behaves and their perceived temperament and maternal self-efficacy can mediate the relationship between maternal competence and perceptions of infant difficulty (Teti and Gelfand, 1991).

Data on parenting across different ethnic groups in the United Kingdom are sparse; historically, this paucity of information, coupled with observations about poor child outcomes, has led to detrimental and damaging assumptions about parenting style (Phoenix and Hussain, 2007). Recent work has indicated that compared with a white group, Pakistani mothers of primary aged children were more likely to report following through threats of discipline (Ali and Frederickson, 2011), and ethnic minority teenagers more likely to rate their parents as displaying less care and exerting greater control over their lives (Maynard and Harding, 2010). However, we are not aware of studies that examine parental styles of very young children in the UK's South Asian population, and mothers' reports of their infants' temperament lack an ethnic minority focus (Sanson *et al.*, 2004). Such information would enhance our understanding on the emergence of early variation in parenting and any differential in interaction between parenting style and children's temperament among ethnic minority groups.

Here, using data from a recent multi-ethnic community birth cohort of infants in Bradford, UK, we examine variation between ethnic groups in mothers' reports of their parenting style, confidence in parenting and their infants' temperament.

Methods

Study sample

The data come from a subset of women recruited to the Born in Bradford (BiB) cohort, a longitudinal community study aiming to assess the impact of environmental, psychological and genetic factors on maternal and child health and well-being (Raynor and Born in Bradford Collaborative Group, 2008). Bradford is a city in the North of England with high levels of socio-economic deprivation and ethnic diversity, with 14.5% of the population and 27.6% of children aged from birth to four years reported to be of Pakistani ethnicity at the 2001 Census and 11.8% of the city's population born outside of the United Kingdom (Office for National Statistics, 2001). The full BiB cohort recruited 12,453 women comprising 13,776 pregnancies antenatally. Women who enrolled between August 2008 and March 2009 and completed the baseline questionnaire at around 26–28 weeks' gestation were approached for recruitment to a sub-study (BiB1000), for which consent was sought to repeat visits at 6, 12, 18, 24 and 36 months post-partum. Out of 1917 eligible

pregnancies, 1736 mothers agreed to take part in the BiB1000 study. This article reports on data from the 1306 mothers of singleton births seen at six months (range five to nine months) postnatally, between April 2009 and March 2010. Ethical approval for the data collection was granted by the Bradford Research Ethics Committee (Ref 07/H1302/112).

Data collection

Outcome variables. The outcome variables were self-reported at the six-month postnatal visit. Our main outcome was parenting style measured with questions used by other large cohort studies in the United States, Canada and Australia (Cohen et al., 1977; Dibble and Cohen, 1974; Sanson, 1995). These questions formed three domains of parenting: self-efficacy, parental warmth and parental hostility (Table 1). Most women rated themselves as being warm, self-efficacious and not hostile. Because of this skewed distribution, the scores for each domain were summed and the fifth with the lowest scores were classified as having lower parental self-efficacy and warmth and higher hostility (Australian Institute of Family Studies, 2006). We used exploratory factor analysis (EFA) in MPlus version 5.21 to assess the strength of fit of the parenting questionnaire data to the hypothesised structure. We treated the items as continuous and used a maximum likelihood estimator with robust standard errors to account for any non-normality. We employed commonly used parameters to indicate a good fit: comparative fit index (CFI) ≥ 0.95 , root mean square error of approximation (RMSEA) ≤ 0.08 and standardised root mean square residual (SRMR) ≤ 0.06 , specifying a two-factor model for the questions relating to parenting warmth and hostility and a single-factor model for self-efficacy. We examined the fit for each ethnic group separately, then tested for the same factor structure in each group by specifying an exploratory structural equation model (ESEM) with all factors free and then nested with factor loading constrained (Asparouhov and Muthén, 2009). We considered a change in the CFI fit parameter of <0.01 to indicate a similar factor structure in each group. An additional question asked mothers to reflect on their confidence as a parent.

The other outcome was the mothers' perception of the child's difficulties as measured by the Infant Characteristic Questionnaire (ICQ) (Bates et al., 1979), a 24-item instrument in which the mother rates her infant's temperament and behaviour on a scale of 1 to 7 in four domains: the mother's perception that the baby is fussy or difficult, unadaptable to new stimuli, less social and active and harder to predict their needs (Table 1). To reflect the infants' positive characteristics, we relabelled the sub-scales to indicate children with easy temperaments, adaptable, social and active, and predictable. Due to non-normal distribution, the scores for each domain were summed and the fifth with the highest scores were classified as having more a problematic temperament in that domain. As for the parenting domains, classification in the quintile of highest scores may not reflect clinical problems. We used EFA and ESEM to assess the fit of the data to the child temperament measure, specifying a four-factor model and removing items that cross loaded, did not load onto any factor or did not load onto the hypothesised factor. To obtain an overall indicator of child temperament, we generated a total score summing the retained item scores and calculated Cronbach's α as a measure of item reliability.

Independent variables

Most of the demographic variables came from the baseline antenatal questionnaire. Self-defined ethnic group and cultural background were based on the UK's 2001 census and responses were

Prady et al.

Table 1. Parenting questions and the Infant Characteristics Questionnaire.

Parenting questions	
Parental self-efficacy: each question measured on a scale from 1 'Not at all how I feel' to 10 'Exactly how I feel'	<p>I feel I am very good at keeping this child amused</p> <p>I feel that I am very good at calming this child when he/she is upset</p> <p>I feel I am very good at keeping this child busy while I am doing housework</p> <p>I feel that I am very good at routine tasks of caring for this child (feeding him/her, changing his or her nappies and giving him/her a bath)</p>
Parental warmth: each question measured on a scale from 1 'Never/almost never' to 5 'Always/almost always'	<p>How often do you express affection by hugging, kissing and holding this child?</p> <p>How often do you hug or hold this child for no particular reason?</p> <p>How often do you tell this child how happy he/she makes you feel?</p> <p>How often do you have warm, close times together with this child?</p> <p>How often do you enjoy doing things with this child?</p> <p>How often do you feel close to this child both when he/she is happy and he/she is upset?</p>
Hostile parenting: each question measured on a scale from 1 'Not at all' to 10 'All the time'	<p>I have been angry with this child</p> <p>I have raised my voice with or shouted at this child</p> <p>When this child cries, he/she gets on my nerves</p> <p>I have lost my temper with this child</p> <p>I have left this child alone in his/her bedroom when he/she was particularly upset</p>
Parental confidence: one question 'I am ...'	<p>Not very good at being a parent</p> <p>A person who has some trouble being a parent</p> <p>An average parent</p> <p>A better than average parent</p> <p>A very good parent</p>
Infant Characteristics Questionnaire	
Easy temperament (reflected fussy/difficult)	Retained
Mean score (SE)	5. How many times per day, on the average, does your baby get fussy and irritable – for either short or long periods of time?
White British 21.0 (0.34)	6. How much does your baby cry and fuss in general?
Pakistani 20.8 (0.29)	12. How easily does your infant get upset?
	13. When your baby gets upset (e.g. before feeding, during diapering, etc.), how vigorously or loudly does he/she cry and fuss?
	14. How does your baby react when you are dressing him/her?
	22. How changeable is your baby's mood?
	24. Please rate the overall degree of difficulty your baby would present for the average mother.
	Not retained
	1. How easy or difficult is it for you to calm or soothe your baby when he/she is upset?
	17. What kind of mood is your baby generally in?

(continued)

Table 1. (continued)

Infant Characteristics Questionnaire

Adaptable (reflected unadaptable)	Retained
Mean score (SE)	9. How does your baby typically respond to a new person?
White British 9.7 (0.21)	10. How does your baby typically respond to being in a new place?
Pakistani 10.5 (0.21)	11. How well does your baby adapt to things (such as in items 7–10) eventually?
	20. How does your baby respond to disruptions and changes in everyday routine, such as when you go to church or a meeting, on trips, etc.?
	Not retained
Predictable (reflected unpredictable)	7. How did your baby respond to his/her first bath?
Mean score (SE)	Retained
White British 7.3 (0.15)	2. How easy or difficult is it for you to predict when your baby will go to sleep and wake up?
Pakistani 7.2 (0.14)	3. How easy or difficult is it for you to predict when your baby will become hungry?
	4. How easy or difficult is it for you to know what's bothering your baby when he/she cries or fusses?
	Not retained
Social and active (reflected dull)	8. How did your baby respond to his/her first solid food?
Not retained – trivial factor	19. How much does your baby want to be held?
	21. How easy is it for you to predict when your baby will need a diaper change?
	15. How active is your baby in general?
	16. How much does your baby smile and make happy sounds?
	18. How much does your baby enjoy playing little games with you?
	23. How excited does your baby become when people play with or talk to him/her?

SE: standard error.

classified into the two most numerous groups of White British and Pakistani; all other responses formed a heterogeneous group ($N = 177$), which we did not analyse. We noted the country of birth and categorised the mother's age at recruitment as young (<20 years), average childbearing age (20–34 years) and older (35+ years). Parity was classified from 0 to 3 or more. We categorised the mother's highest educational qualification, equivalising to the United Kingdom in cases where education was obtained abroad. Over 35% of the South Asian women did not know or did not report the amount of household income, so we used the response to a question on financial security: 'How well would you say you or you and your husband/partner are managing financially these days?' We categorised those who reported 'living comfortably' or 'doing alright' as financially secure and those who responded 'just about getting by', 'finding it quite- or very difficult' as struggling financially. The few cases ($N = 5$) of non-response we classified as financially secure. Finally, the sex of the baby was gathered from the electronic maternity record system.

Marital status and the mental health variable were collected at the six-month postnatal visit. We classified relationship status at six months as married, cohabiting, not living with

Table 2. Population characteristics by ethnicity.

Variable	Category	White British N = 439	Pakistani N = 554	Total N = 993
Baby's sex	Male	215 (49.0)	272 (49.1)	487 (49.0)
	Female	224 (51.0)	282 (50.9)	506 (51.0)
Mother's education	<5 GCSE equivalent	83 (18.9)	130 (23.5)	213 (21.5)
	5 GCSE equivalent	151 (34.4)	175 (31.6)	326 (32.8)
	A-level equivalent	73 (16.6)	68 (12.3)	141 (14.2)
	>A-level equivalent	97 (22.1)	155 (28.0)	252 (25.4)
	Other	32 (7.3)	16 (2.9)	48 (4.8)
	Don't know	3 (0.7)	10 (1.8)	13 (1.3)
Mother's age (at recruitment)	<20 years	42 (9.6)	14 (2.5)	56 (5.6)
	20–34 years	336 (76.5)	480 (86.6)	816 (82.2)
	35+ years	61 (13.9)	60 (10.8)	121 (12.2)
Parity	0	214 (48.8)	185 (33.4)	399 (40.2)
	1	135 (30.8)	163 (29.4)	298 (30.0)
	2	50 (11.4)	94 (17.0)	144 (14.5)
	3+	40 (9.1)	112 (20.0)	152 (15.3)
Financial security	Financially secure	303 (69.0)	387 (69.9)	690 (69.5)
	Not financially secure	136 (31.0)	316 (30.1)	303 (30.5)
Relationship status at 6 month visit	Married	170 (38.2)	523 (94.4)	693 (69.8)
	Cohabiting	180 (41.0)	1 (0.2)	181 (18.2)
	Lone parent in a relationship	45 (10.3)	14 (2.5)	59 (5.9)
	Lone parent not in a relationship	44 (10.0)	16 (2.9)	60 (6.0)
Mother's mental health	Not distressed	378 (86.1)	430 (77.6)	808 (81.4)
	Distressed	61 (13.9)	124 (22.4)	185 (18.6)
Mother's country of birth*	Born in the United Kingdom	439 (100)	238 (43.0)	664 (66.9)
	Born overseas	0	124 (57.0)	329 (33.1)
Language of 6-month questionnaire*	English	434 (98.9)	373 (67.3)	807 (81.3)
	Non-English	1 (0.2)	177 (31.9)	178 (17.9)
	Missing	4 (0.9)	4 (0.7)	8 (0.8)

Note: Percentages may not total to 100 due to rounding.

*Variable not used in the analysis; GCSE: General Certificate of Secondary Education.

a partner but in a relationship, and not living with a partner and not in a relationship. We noted the language in which the questionnaire was completed. As a measure of mental health, we took four questions from the general health questionnaire (GHQ)-28 (Goldberg and Hillier, 1979), each scored from 0 to 3 to with 0 indicating no symptom endorsement. We selected these four questions because they appeared to be measuring the same underlying concept of severe depression in both the White and Pakistani populations (Prady et al., 2011). We categorised women who did not endorse any of the four items as non-distressed and endorsement of at least one item as distressed, using these terms as indicating psychological distress, not psychiatric diagnoses.

Overall, one-third of the included mothers reported struggling financially (Table 2). In all, 33% of Pakistani mothers were nulliparous and 5.4% not living with a partner, compared with 49% and 20.3% of White British mothers, respectively. In all, 58% of the Pakistani mothers had migrated to the United Kingdom and 33% elected to complete the six-month questionnaire in a language other than English.

Missing values

We excluded cases with missing ethnicity data ($N = 2$), where any of the responses to the questions in each parenting domain or each child temperament domain were missing ($N = 75$) or where other covariates were missing (a further 59 cases). This led to the exclusion of 8.9% of the White British cases and 14.1% of the Pakistani cases, leaving 439 White British and 554 Pakistani women in the analysis.

Statistical methods

We compared basic characteristics of included versus excluded women using chi-square tests. For the parental confidence question, we tabulated the categories endorsed by each ethnic group. For each parenting domain, the indicators for 'lower parental confidence', 'lower parental warmth' or 'higher parental hostility' were used as binary outcomes in logistic regression models to investigate the relationship between parenting and ethnicity. We ran four models: (1) unadjusted, (2) also adjusted for psychological distress, (3) also adjusted for total child difficulty score and (4) also adjusted for socio-demographic variables (baby sex, mother's education, mother's age as a continuous variable, parity, financial security, marital status). For the infant temperament analyses, we used the indicators for 'easy temperament', 'adaptable' and 'predictable' as binary outcomes in logistic regression, with ethnicity as the independent variable. As for the parenting models, we also adjusted for mental health and socio-demographic variables. We compared the mean overall child temperament score from women with higher and lower parenting practices both overall (t test) and between ethnic groups using one-way analysis of variance.

To explore how self-reported parenting factors and child temperament might vary with less experience of child-rearing (Fisher and Stifter, 1993; Mebert and Kalimowski, 1986), we ran sensitivity analyses using data only from the nulliparous women. We used Stata 11 (StataCorp LP, Texas) for the analysis and considered probabilities below $\alpha < 0.05$ to indicate statistical significance.

Results

Assessment of generalizability

Comparing included and excluded cases, there was little evidence that those excluded due to missing a parenting or child temperament outcome differed from those included by ethnic group, $\chi^2(1) = 2.2$, $p = 0.14$, financial well-being, $\chi^2(1) = 0.96$, $p = 0.33$ or language of questionnaire administration (English vs. non-English, $\chi^2(1) = 1.02$, $p = 0.31$). The ratio of included White British to Pakistani women (1:1.26) is similar to the whole cohort (1:1.14), which is in turn broadly reflective of Bradford's maternal population (Wright et al., 2012).

Parental confidence

The Pakistani women reported feeling more confident in their abilities as mothers (Table 3). The category the White British women endorsed the most was that of an 'average parent' (39.7%), whereas Pakistani women endorsed the category of being a 'very good parent' most often (49.1%).

Table 3. Ethnic differences in parental confidence.

	White British	Pakistani	Total
Not very good at being a parent	3 (0.7)	3 (0.6)	6 (0.6)
Some trouble being a parent	11 (2.5)	7 (1.3)	18 (1.8)
An average parent	173 (39.7)	151 (27.6)	324 (32.9)
A better than average parent	102 (23.4)	118 (21.5)	220 (22.4)
A very good parent	147 (33.7)	269 (49.1)	416 (42.3)

Note: Column percentages, 9 cases missing (3 White British and 6 Pakistani).

Table 4. Parenting and infant temperament scores by ethnicity.

	White British	Pakistani	Total
Parental self-efficacy – range 4 (least) to 40 (most self-efficacious)	35 (31, 38)	36 (30, 40)	35 (30, 39)
Parental warmth – range 5 (least) to 30 (most warm)	28 (26, 30)	28 (26, 30)	28 (26, 30)
Hostile parenting – range 5 (least) to 50 (most hostile)	6 (5, 9)	5 (5, 8)	6 (5, 8)
Infant characteristics			
Easy temperament – range 7 (most) to 49 (least easy)	21 (16, 26)	21 (16, 25)	21 (16, 25)
Adaptable – range 4 (most) to 28 (least adaptable)	9 (6, 13)	10 (7, 14)	10 (7, 13)
Predictable – range 3 (most) to 21 (least predictable)	7 (5, 9)	6 (4, 9)	7 (4, 9)

Note: Numbers are median (interquartile range).

Psychometric analysis

Fit of the data to the parenting measures for both groups was good on two of the fit statistics for the warmth and hostility composite and all three for the self-efficacy factor. The majority of items loaded between 0.5 and 0.8, with no non-loading (<0.3) or cross-loading items. There was no appreciable change in fit when the factor loadings were constrained ($\Delta\text{CFI} = 0.002$ for self-efficacy, 0.007 for warmth and hostility), indicating a similar factor structure for both ethnic groups.

The fit of the infant temperament scale was also good. Several items were indiscriminate in both groups: item 1 cross loaded (>0.3); items 15, 17 and 19 did not load onto the hypothesised factor (along with item 21 in the Pakistani group only) and items 7 and 8 did not load onto any factor (<0.3). After the removal of these items, post-rotation eigenvalues revealed the three remaining items in the ‘social and active’ factor to be trivial in both groups (<1). This factor was removed, leaving 14 items comprising three factors (Table 1), with the easy temperament factor accounting for the most variance in each group. There was no appreciable change in fit when the factor loadings were constrained for this reduced item set ($\Delta\text{CFI} = 0.005$). Item consistency was high for the 14 retained items summed as the total score of the ICQ (Cronbach’s $\alpha = 0.80$). Summary outcome data are presented in Table 4.

Parenting style

There was little evidence that parenting style differed between ethnic groups (Table 5). There was some evidence that Pakistani women were less likely to be classified as having a more hostile parenting style (odds ratio (OR) 0.71; 95% confidence interval (CI) 0.53, 0.95). This difference

Table 5. Logistic regression of parenting practices by ethnicity.

	Model 1 unadjusted OR (95% CI)	Model 2 adjusted OR (95% CI)	Model 3 adjusted OR (95% CI)	Model 4 adjusted OR (95% CI)
Low self-efficacy				
White British	1 -	1 -	1 -	1 -
Pakistani	1.12 (0.82, 1.52)	1.06 (0.78, 1.44)	1.06 (0.76, 1.47)	1.08 (0.70, 1.67)
Low parental warmth				
White British	1 -	1 -	1 -	1 -
Pakistani	1.13 (0.83, 1.54)	1.15 (0.84, 1.56)	1.14 (0.84, 1.56)	1.16 (0.76, 1.77)
Hostile parenting				
White British	1 -	1 -	1 -	1 -
Pakistani	0.71 (0.53, 0.95)*	0.68 (0.51, 0.92)*	0.66 (0.49, 0.90)**	0.69 (0.47, 1.03)

OR: odds ratio; CI: confidence interval.

Note: An OR above 1 indicates more problems in that domain, below 1 indicates fewer problems. Model 2 adjusted for psychological distress; model 3 also adjusted for total child difficulty score. model 4 also adjusted for baby sex, mother's education, mother's age, parity, financial security and marital status; statistically significant estimates are in boldface.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

persisted after adjusting for mental health and total child difficulty score, but was no longer statistically significant after adjusting for socio-demographic characteristics.

Infant temperament

There was little evidence of differences in infant characteristics by ethnic group (Table 6). Across ethnic groups, those with more positive parenting practices (high self-efficacy, high warmth, low hostility) reported less problematic infant temperament scores (Table 7). White British women with higher and lower self-efficacy reported that their infants, on average, had easier and more difficult temperaments, respectively, compared to Pakistani women with similar parenting practices. The absolute difference in infant temperament was 1.6% for higher and 4.6% for lower self-efficacy.

Sensitivity analysis

We conducted a sensitivity analysis to explore how experience with child-rearing might have affected our estimates. There was some limited evidence to suggest that nulliparous White British women might be more confident and have less hostile parenting than their multiparous counterparts.

Discussion

The aim of our research was to describe any differences in early parenting behaviours and infant temperament between ethnic groups as a link to markers of children's future health and well-being in an economically deprived city-based sample. To our knowledge, no such data have been reported previously for UK-resident women. We found that women of Pakistani origin reported having more confidence in their parenting than the other mothers. They also reported less hostile parenting. There was little evidence of any differences in the report of infant temperament except

Prady et al.

Table 6. Logistic regression of child temperament by ethnicity.

	Model 1 unadjusted OR (95% CI)	Model 2 adjusted OR (95% CI)	Model 3 adjusted OR (95% CI)
Easy temperament			
White British	1 -	1 -	1 -
Pakistani	0.93 (0.68, 1.27)	0.88 (0.64, 1.21)	0.83 (0.55, 1.26)
Adaptable			
White British	1 -	1 -	1 -
Pakistani	1.30 (0.96, 1.75)	1.27 (0.94, 1.72)	1.19 (0.79, 1.77)
Predictable			
White British	1 -	1 -	1 -
Pakistani	0.99 (0.74, 1.33)	0.96 (0.71, 1.29)	0.95 (0.64, 1.40)

OR: odds ratio; CI: confidence interval.

Note: An OR above 1 indicates more problems in that domain, below 1 indicates fewer problems. Model 2 adjusted for psychological distress. Model 3 also adjusted for baby sex, mother's education, mother's age, parity, financial security and marital status.

Table 7. Ethnic differences in reporting child temperament by parenting style.

	Self-efficacy		Parental warmth		Hostile parenting	
	Higher	Lower	Higher	Lower	Lower	Higher
White British	35.4 (0.54)	48.1 (1.16)	37.0 (0.60)	42.0 (1.22)	35.7 (0.60)	44.1 (1.05)
Pakistani	37.0 (0.53)	43.6 (0.95)	37.7 (0.54)	41.0 (0.97)	37.2 (0.53)	43.2 (0.98)
Total	36.3 (0.38)	45.5 (0.74)	37.4 (0.40)	41.4 (0.76)	36.6 (0.40)	43.6 (0.72)
Difference between total high/low	$d = -9.23, t = -11.2, p < 0.001$		$d = -3.98, t = -4.6, p < 0.001$		$d = -7.09, t = -8.7, p < 0.001$	
White British cf Pakistani*	$d = -1.6$ $f(1, 777) = 4.3$ $p = 0.04$	$d = 4.5$ $f(1, 212) = 9.4$ $p = 0.003$	$d = -0.7$ $f(1, 778) = 0.79$ $p = 0.38$	$d = 1.0$ $f(1, 211) = 0.40$ $p = 0.53$	$d = -1.5$ $f(1, 752) = 3.5$ $p = 0.06$	$d = 0.9$ $f(1, 237) = 0.44$ $p = 0.51$

Note: Unless otherwise noted, estimates are mean (standard error) of the total child temperament questionnaire.

*One-way analysis of variance; statistically significant estimates are in boldface.

that self-efficacious Pakistani women reported more problems with their infant's temperament than White British women (unadjusted analysis), and those with lower self-efficacy reported fewer problems. Although statistically significant, however, differences in temperament scores were low (<5 percentage points) and may have little 'real world' relevance to actual infant behaviour.

One explanation of why Pakistani mothers may be more critical of their infant's temperament is that they hold higher expectations for their child's behaviour. This could be a function of community-facing *Izzat* (pride) that needs to be upheld by the whole family, including children (Stewart et al., 1999). Indeed, this raises the hypothesis that some of the excess in parentally reported child behaviour problems for Pakistani children in the Millennium Cohort Study (Dearden and Sibieta, 2010) might be due to mothers being systematically overcritical of their children's behaviour compared to other groups (Prady and Kiernan, 2012). Not against this idea are the results from a national survey that used independent interviewers and multi-informants (parents, teachers and children), which indicated that Pakistani children had a *lower* risk of mental health problems compared to the majority of the white population (Meltzer et al., 2000).

Women brought up in Pakistan might have greater exposure to a parenting style influenced by different circumstances than those in the United Kingdom, which could result in adoption of a more traditional style that incorporates higher hostility or similar dimensions (e.g. Ali and Frederickson, 2011; Maynard and Harding, 2010) but more assured and confident parenting. As nearly one-half of the Pakistani women in this analysis were born in the United Kingdom, it is possible that acculturation processes that widen social and support networks over time for migrants (Samad, 2010) reduced any variation in parenting resulting from generational status.

Across this sample, women with warmer, more efficacious and less hostile practices reported fewer problems with their infants' temperament. In this article, we analysed subjectively reported perception of parenting style and infant characteristics which assess the infant in the context of the stimulation provided in the home (Rothbart, 1982). In addition to individual variation in this home environment, more problematic infant characteristics scores can be influenced by maternal depression (Meredith and Noller, 2003) and parental distress (Mantymaa et al., 2006), but we did not find attenuation after adjustment for the worse mental health reported by Pakistani women.

We did find that the association between less hostile parenting in the Pakistani group attenuated after full adjustment, indicating that *other things being equal*, Pakistani mothers do not report practicing less hostile parenting. However, in the United Kingdom, 'things' are not equal, and South Asian groups can suffer lower socio-economic status (SES) and more mental health problems due to racism and discrimination (Hussain and Cochrane, 2004; Nazroo, 2003). The implication being that despite increased adversity that would seemingly put them at risk for less benevolent parenting practices, Pakistani mothers might adopt a parenting style that minimises hostility, which might serve to buffer the negative effect of low SES on the healthy development of the increasing number of children of South Asian origin growing up in the United Kingdom. Adoption of such enhanced parenting practices under adversity has been noted elsewhere (Armistead et al., 2002). However, as differences in other parenting dimensions such as care, control and discipline have been noted in other UK samples of South Asian parents of older children (Ali and Frederickson, 2011; Maynard and Harding, 2010), we suggest further verification work is needed across a wider age range of children and across their life course.

Responses to the parental confidence question were in line with those found in an Australian infant cohort (Weston et al., 2006), with ~98% of mothers rating themselves as being an average parent or better. Looking at the more positive reports of confidence, in our sample 34% of the White British mothers considered themselves to be very good parents, less than the Australian sample of 42%, but 49% of Pakistani mothers rated themselves this highly. This higher confidence reported by Pakistani women merits further exploration.

Strengths and limitations

We took a rigorous approach to assessing whether the concepts relating to infant temperament and parenting measures were similar between the ethnic groups, finding them broadly equivalent. This increases our confidence that we can compare these concepts between groups, although there may be residual measurement error due to differences in the way women of different ethnicities respond to items, which may have interfered with our findings. It remains a possibility that ethnic groups have different cultural norms around classification of parenting behaviour and infant temperament (Chao, 1994; Stewart and Bond, 2002) and differences in home environment that contextualise behaviour (Rothbart, 1982). However, as we saw few differences, it is possible they are either

attenuated by possible measurement error or so small as to be negligible in effect. We summed the total score of the infant temperament measurement as a gross measure of total difficulties; and although we found item reliability to be high, we acknowledge this is not a previously validated use of the instrument.

Our ethnic categorisation included culturally heterogeneous groups, with a third of the Pakistani group choosing not to complete the questionnaire in English and over one-half being born outside of the United Kingdom. Such ethnicity-based classifications are unsatisfactory (Sheldon and Parker, 1992), and this variation might explain why we did not find associations between ethnicity and parenting or infant temperament. The strength of BiB is that it is drawn from a community of women in a single geographical area, and, compared with nationally representative birth cohorts, there would not be as large a variation in environmental and social factors. However, generalizability of our findings to other established communities of migrant Pakistani families needs verification.

The data we present, as with much research in this area, are limited by its cross-sectional and self-reported nature. If the development of parenting practice in reaction to infant temperament, and vice-versa, differs between ethnic groups, then this is a potential limitation of our analysis.

Implications

Our study indicates few differences in self-reported parenting by ethnicity, which implies universal monitoring and intervention for problematic parenting. Although infants classified as having 'problematic' temperaments may not automatically be at risk for developmental problems (Rothbart, 1982), longitudinal work has implicated problems in early parenting and infant temperament to be predictive of behavioural problems in four- to five-year-olds (Christensen et al., 2011). Accordingly, in the future we plan to follow the health, behaviour and educational attainment of these children to examine the association between early parenting and later childhood well-being such as the association of parenting and infant temperament on child growth (Botton et al., 2008; Hubbs-Tait et al., 2008; McCarthy et al., 2007).

In conclusion, we found some evidence of differences between self-reported parenting between White British and Pakistani women living in an economically deprived UK city, which were mostly explained by variation in economic and demographic status characteristics. It would seem unlikely that the ethnic variation seen in children's cognitive and behavioural outcomes in early childhood (Dearden and Sibiet, 2010) is attributable to differences in parenting practices or infant characteristics reported at six months. The finding that Pakistani mothers report being more confident in their parenting abilities and adopt a less hostile style merits verification and further investigation in terms of possible mediators of child outcomes.

Acknowledgements

We are grateful to all the families who took part in this study, to the midwives for their help in recruiting them, the paediatricians and health visitors and to the Born in Bradford team, which included interviewers, data managers, laboratory staff, clerical workers, research scientists, volunteers and managers. We acknowledge the thoughtful comments of Dr Rosie McEachan on a draft manuscript.

Funding

This work was funded by an NIHR CLAHRC implementation grant (KRD/012/001/006); an NIHR applied programme grant (RP-PG-0407-10044) and an ESRC research grant (RES-177-25-0016).

This article presents independent research commissioned by the National Institute for Health Research (NIHR) under the CLAHRC programme. The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health.

References

- Ali S and Frederickson N (2011) The parenting dimensions of British Pakistani and White mothers of primary school children. *Infant and Child Development* 20: 313–329.
- Armistead L, Forehand R, Brody G, et al. (2002) Parenting and child psychosocial adjustment in single-parent African American families: Is community context important? *Behavior Therapy* 33: 361–375.
- Asparouhov T and Muthén B (2009) Exploratory structural equation modeling. *Structural Equation Modeling* 16: 397–438.
- Australian Institute of Family Studies (2006) *Growing Up in Australia: The Longitudinal Study of Australian Children: 2005–06 Annual Report*. Melbourne, Australia: Australian Institute of Family Studies, pp. 1–44.
- Bates JE, Freeland CA and Lounsbury ML (1979) Measurement of infant difficultness. *Child Development* 50: 794–803.
- Baumrind D (1991) The influence of parenting style on adolescent competence and substance use. *Journal of Early Adolescence* 11: 56–95.
- Baumrind D, Larzelere RE and Owens EB (2010) Effects of preschool parents' power assertive patterns and practices on adolescent development. *Parenting* 10: 157–201.
- Berg-Nielsen TS, Vikan A and Dahl AA (2002) Parenting related to child and parental psychopathology: A descriptive review of the literature. *Clinical Child Psychology and Psychiatry* 7: 529–552.
- Botton J, Heude B, Maccario J, et al. (2008) Postnatal weight and height growth velocities at different ages between birth and 5 years and body composition in adolescent boys and girls. *American Journal of Clinical Nutrition* 87: 1760–1768.
- Bradshaw CP and Hazan C (2006) Examining views of self in relation to views of others: Implications for research on aggression and self-esteem. *Journal of Research in Personality* 40: 1209–1218.
- Chao RK (1994) Beyond parental control and authoritarian parenting style: Understanding Chinese parenting through the cultural notion of training. *Child Development* 65: 1111–1119.
- Christensen D, Lawrence D, Mitrou F, et al. (2011) Child temperament, parenting style and emotional and behavioural problems in early childhood findings from the longitudinal study of Australian children. In: *LSAC-LSIC Conference 2012*. Melbourne. (Unpublished).
- Cohen DJ, Dibble E and Grawe JM (1977) Parental style: Mothers' and fathers' perceptions of their relations with twin children. *Archives of General Psychiatry* 34: 445–451.
- Coie JD and Dodge KA (1998) Aggression and antisocial behavior. In: Damon W and Eisenberg N (eds) *Handbook of Child Psychology: Social, Emotional, and Personality Development*. New York, NY: Wiley, pp. 779–862.
- Cummings EM and Davies PT (1994) Maternal depression and child development. *Journal of Child Psychology and Psychiatry* 35: 73–112.
- Dearden L and Sibiet L (2010) Ethnic inequalities in child outcomes. In: Hansen K, Joshi H and Dex S (eds) *Children of the 21st Century: The First Five Years*. Bristol, UK: The Policy Press.
- Dibble E and Cohen DJ (1974) Companion instruments for measuring children's competence and parental style. *Archives of General Psychiatry* 30: 805–815.
- Fisher M and Stifter CA (1993) Mother parity as a main and moderating influence on early mother–infant interaction. *Journal of Applied Developmental Psychology* 14: 557–572.

- Flores G and The Committee on Pediatric Research (2010) Technical report – racial and ethnic disparities in the health and health care of children. *Pediatrics* 125: e979–e1020.
- Goldberg DP and Hillier VF (1979) A scaled version of the general health questionnaire. *Psychological Medicine* 9: 139–145.
- Goodman A, Lamping DL and Ploubidis GB (2010) When to use broader internalising and externalising subscales instead of the hypothesised five subscales on the strengths and difficulties questionnaire (SDQ): Data from British parents, teachers and children. *Journal of Abnormal Child Psychology* 38: 1179–1191.
- Hubbs-Tait L, Kennedy TS, Page MC, et al. (2008) Parental feeding practices predict authoritative, authoritarian, and permissive parenting styles. *Journal of the American Dietetic Association* 108: 1154–1161.
- Hussain F and Cochrane R (2004) Depression in South Asian women living in the UK: A review of the literature with implications for service provision. *Transcultural Psychiatry* 41: 253–270.
- Kelly Y, Sacker A, Schoon I, et al. (2006) Ethnic differences in achievement of developmental milestones by 9 months of age: The Millennium Cohort Study. *Developmental Medicine and Child Neurology* 48: 825–830.
- Landy S and Tam KK (1998) *Understanding the Contribution of Multiple Risk Factors on Child Development at Various Ages*. Canada: Applied Research Branch, Strategic Policy, Human Resources Development.
- Lupton R and Power A (2004) *Minority Ethnic Groups in Britain. CASE-Brookings Census Briefs No. 2*. London, UK: London School of Economics.
- McCarthy A, Hughes R, Tilling K, et al. (2007) Birth weight, post-natal, infant and childhood growth and obesity in young adulthood: Evidence from the Barry Caerphilly Growth (BCG) study. *American Journal of Clinical Nutrition* 86: 907–913.
- Maccoby EE and Martin JA (1983) Socialization in the context of the family: Parent–child interaction. In: Hetherington EM (ed.) *Handbook of Child Psychology, Vol. 4: Socialization, Personality, and Social Development*, 4 edn. New York, NY: Wiley, pp. 1–101.
- Mantymaa M, Puura K, Luoma I, et al. (2006) Mother’s early perception of her infant’s difficult temperament, parenting stress and early mother–infant interaction. *Nordic Journal of Psychiatry* 60: 379–386.
- Maynard MJ and Harding S (2010) Perceived parenting and psychological well-being in UK ethnic minority adolescents. *Child: Care, Health and Development* 36: 630–638.
- Mebert CJ and Kalimowski MF (1986) Parents’ expectations and perceptions of infant temperament: “pregnancy status” differences. *Infant Behavior and Development* 9: 321–334.
- Meltzer H, Gatwood R, Goodman R, et al. (2000) *Mental Health of Children and Adolescents in Great Britain*. London, UK: Office of National Statistics.
- Meredith P and Noller P (2003) Attachment and infant difficultness in postnatal depression. *Journal of Family Issues* 24: 668–686.
- Milliones J (1978) Relationship between perceived child temperament and maternal behaviours. *Child Development* 49: 1255–1257.
- National Research Council (2000) *Nurturing Relationships. From Neurons to Neighborhoods: The Science of Early Childhood Development*. Washington, DC: National Academy Press, pp. 225–266.
- Nazroo JY (2003) The structuring of ethnic inequalities in health: Economic position, racial discrimination, and racism. *American Journal of Public Health* 93: 277–284.
- Office for National Statistics (2001) Neighbourhood Statistics: Tables UV08, UV09 and nomis table S101. 2001 census. London, UK: Office for National Statistics
- Phoenix A and Hussain F (2007) *Parenting and Ethnicity*. York, UK: Joseph Rowntree Foundation.
- Prady SL and Kiernan KE (2012) The effect of post-natal mental distress amongst Indian and Pakistani mothers living in England on children’s behavioural outcomes. *Child: Care, Health and Development*. Epub ahead of print 29 August 2012. DOI: 10.1111/j.1365-2214.2012.01426.x.

- Prady SL, Miles JNV, Pickett KE, Fairley L, Bloor K, et al. (2013) The psychometric properties of the sub-scales of the GHQ-28 in a multi-ethnic maternal sample: results from the Born in Bradford cohort. *BMC Psychiatry* 13: doi:10.1186/1471-1244X-1113-1155.
- Putnam SP, Sanson AV and Rothbert MK (2002) Child temperament and parenting. In: Bornstein MH (ed.) *Children and Parenting*. Routledge.
- Raynor P and Born in Bradford Collaborative Group (2008) Born in Bradford, a cohort study of babies born in Bradford, and their parents: Protocol for the recruitment phase. *BMC Public Health* 8: 327.
- Rothbart MK (1981) Measurement of temperament in infancy. *Child Development* 52: 569–578.
- Rothbart MK (1982) The concept of difficult temperament: A critical analysis of Thomas, Chess and Korn. *Merrill-Palmer Quarterly* 28: 35–39.
- Samad Y (2010) *Muslims and Community Cohesion in Bradford*. York, UK: Joseph Rowntree Foundation.
- Sanson AV (1995) *Childrearing Questionnaire*. Unpublished scale. University of Melbourne, Australia.
- Sanson AV, Hemphill SA and Smart D (2004) Connections between temperament and social development: A review. *Social Development* 13: 142–170.
- Sheldon TA and Parker H (1992) Race and ethnicity in health research. *Journal of Public Health Medicine* 14: 104–110.
- Siegler R, Deloache J and Eisenberg N (2006) *An Introduction to Child Development*. New York, NY: Worth Publishers.
- Stansfeld SA, Clark C, Rodgers B, et al. (2011) Repeated exposure to socioeconomic disadvantage and health selection as life course pathways to mid-life depressive and anxiety disorders. *Social Psychiatry and Psychiatric Epidemiology* 46: 549–558.
- Stewart SM and Bond MH (2002) A critical look at parenting research from the mainstream: Problems uncovered while adapting western research to non-western cultures. *British Journal of Developmental Psychology* 20: 379–392.
- Stewart SM, Bond MH, Zaman R, et al. (1999) Functional parenting in Pakistan. *International Journal of Behavioural Development* 23: 747–770.
- Teti DM and Gelfand DM (1991) Behavioral competence among mothers of infants in the first year: The mediational role of maternal self-efficacy. *Child Development* 62: 918–929.
- van den Bloom DC, Dymphna C and Hoeksma JB (1994) The effect of infant irritability on mother–infant interaction: A growth-curve analysis. *Developmental Psychology* 30: 581–590.
- Weston R, Soriano G and Qu L (2006) Starting early, starting late: Socio-demographic characteristics and parenting of new mothers of different ages. *Family Matters*: 52–59.
- Wohland P, Rees P, Norman P, et al. (2010) *Ethnic Population Projections for the UK and Local Areas, 2001–2051*. Leeds, UK: University of Leeds, Department of Geography, pp. 1–185.
- Wright J, Small N, Raynor P, et al. (2012) Cohort profile: The Born in Bradford multi-ethnic family cohort study. *International Journal of Epidemiology*. Epub ahead of print 12 October 2012. DOI:10.1093/ije/dys1112.

An exploration and comparison of food and drink availability in homes in a sample family of White and Pakistani origin within the UK

Bryant M, Sahota P, Santorelli G, Hill A, Wright J. An exploration and comparison of food and drink availability in homes in a sample family of White and Pakistani origin within the UK. *Public Health Nutr* 2015;**18**:1197–205.¹⁰⁶ Reproduced with permission from Cambridge University Press.

Public Health Nutrition: 18(7), 1197–1205

doi:10.1017/S1368980014000147

An exploration and comparison of food and drink availability in homes in a sample of families of White and Pakistani origin within the UK

Maria Bryant^{1,2,*}, Pinki Sahota³, Gillian Santorelli² and Andrew Hill⁴

¹Leeds Institute of Clinical Trials Research, University of Leeds, Leeds LS2 9JT, UK; ²Institute of Health Research, Bradford Teaching Hospitals NHS Trust, Bradford, UK; ³Nutrition and Dietetics, Leeds Metropolitan University, Leeds, UK; ⁴Leeds Institute of Health Sciences, University of Leeds, Leeds, UK

Submitted 9 September 2013; Final revision received 17 December 2013; Accepted 30 January 2014; First published online 10 March 2014

Abstract

Objective: Knowledge of the types and quantities of foods and drinks available in family homes supports the development of targeted intervention programmes for obesity prevention or management, or for overall diet improvement. In the UK, contemporary data on foods that are available within family homes are lacking. The present study aimed to explore home food and drink availability in UK homes.

Design: An exploratory study using researcher-conducted home food availability inventories, measuring all foods and drinks within the categories of fruits, vegetables, snack foods and beverages.

Setting: Bradford, a town in the north of the UK.

Subjects: Opportunistic sample of mixed ethnicity families with infants approximately 18 months old from the Born in Bradford birth cohort.

Results: All homes had at least one type of fruit, vegetable and snack available. Fresh fruits commonly available were oranges, bananas, apples, satsumas and grapes. Commonly available fresh vegetables included potatoes, cucumber, tomatoes and carrots. The single greatest non-fresh fruit available in homes was raisins. Non-fresh vegetables contributing the most were frozen mixed vegetables, tinned tomatoes and tinned peas. Ethnic differences were found for the availability of fresh fruits and sugar-sweetened beverages, which were both found in higher amounts in Pakistani homes compared with White homes.

Conclusions: These data contribute to international data on availability and provide an insight into food availability within family homes in the UK. They have also supported a needs assessment of the development of a culturally specific obesity prevention intervention in which fruits and vegetables and sugar-sweetened beverages are targeted.

Keywords
Home food availability
Ethnicity
Inventories
Pantry

There has been increasing interest in the role that food availability in the home has on food consumption and obesity^(1–7). Such information has the potential to increase understanding of the causes of energy over-consumption and provide direction to help create effective obesity prevention interventions. However, research in this area is limited by the methods used to assess food availability. Much of the literature uses data collected using food checklists; a quick and relatively inexpensive method to assess the presence or absence of a predefined list of selected foods using participant self-report. Data collected using this method are limited to the items that have been predefined and cannot therefore capture information on ethnically diverse habits or unexpected patterns. An alternative method to self-report checklists is

to conduct researcher-administered inventories of the home food environment. These involve researchers going into participants' homes and recording all foods and drinks available (fully exhaustive inventories) or all foods and drinks available within predefined categories (partially exhaustive inventories). They are not limited to recording only foods that the researchers have previously assumed to be available in a predefined list. However, few attempts have been made to collect this kind of data owing to issues related to the feasibility of collection and analysis.

A review of methods to collect home food availability data in 2006⁽⁸⁾ identified just three other published studies that had used fully or partially exhaustive inventories since 1975. Since then, some investigators have used

*Corresponding author: Email m.j.bryant@leeds.ac.uk



this approach^(9–11); however, the majority of work has continued to focus on data collection using predefined checklists^(5,6,12). This work has so far been dominated by the USA and indicates that the availability of foods is generally related to consumption in infants and children^(5,13–15) and weight status^(2,5,6), although findings are somewhat equivocal, likely due to the methodologies employed.

To our knowledge, there are no published studies describing home food availability collected using a researcher-conducted approach within populations in the UK. We aimed to explore the home food environment as part of an objective to develop a culturally appropriate obesity prevention intervention within the Born in Bradford-1000 Programme of research⁽¹⁶⁾. Since no other data of this kind have been collected in a mixed ethnic sample in the UK (and thus no appropriate checklist was available), open inventories of foods and drinks within pre-specified categories of fruits, vegetables, snack foods and drinks were conducted by researchers within participants' homes using a well-defined protocol already tested by the authors as part of their work in the USA^(9,10). The present study reports our findings from the inventories to explore which foods were available in the homes of a sample of families of mixed ethnicities when their infants were approximately 18 months old and to identify any differences in availability between White British and Pakistani homes.

Experimental methods

Sample

Participants were opportunistically recruited from Born in Bradford-1000 (BiB1000), a nested cohort within Born in Bradford (BiB). BiB is a longitudinal multi-ethnic birth cohort aiming to examine environmental, psychological and genetic factors that impact on health and development perinatally, during childhood and subsequent adult life, and those that influence their parents' health and well-being. All mothers booked in for a delivery of their baby in Bradford Royal Infirmary from March 2007 to December 2010 were invited to take part in the research during their routine glucose tolerance test at 26–28 weeks. A total of 12 453 pregnant women enrolled who subsequently gave birth to 13 776 babies. A full account of the methods is published elsewhere⁽¹⁷⁾. All mothers recruited to the main BiB cohort study between August 2008 and March 2009 (and who had completed the baseline questionnaire) were approached to take part in BiB1000 and a total of 1736 agreed. One hundred participants were then drawn opportunistically from the BiB1000 cohort to take part in the current food availability study during the 18-month BiB1000 assessment in which all approached agreed to take part. Due to the exploratory nature of the research, a formal sample size calculation was not performed. Inventory data from 100 homes were chosen as this was considered

comparable to previous research⁽⁸⁾; within calculations to detect small to moderate group differences⁽¹⁸⁾; and due to issues of feasibility.

The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Bradford Research Ethics Committee (07/H1302/112). Written or verbal (for mothers unable to read and/or speak English) informed consent was obtained from all participants. Verbal consent was witnessed and formally recorded.

Data collection

Researcher-conducted food availability inventories

Researcher-conducted inventories were conducted in 100 homes when infants were approximately 18 months old. Data collection method, staff training and quality assurance were conducted using a standardised protocol using well-established methodologies from previous research^(9,10). Participants were told that researchers would be visiting their homes and that they would need access to all places in their homes where foods were stored. No incentives were provided. Researchers measured the availability (yes/no), quantity and size of all foods from all food storage areas in participants' homes within the higher categories of fruit (with sub-categories: fresh, tinned, dried and frozen), vegetables (with sub-categories: fresh, tinned and frozen), snack foods (with sub-categories: crisps/tortillas, biscuits, salted nuts, chocolate, sweets, cakes and ice cream) and beverages (with sub-categories: sugar-sweetened and sugar-free). These categories were chosen because: (i) they are often the target of obesity interventions; (ii) there is some evidence that their intake is related to obesity in children^(19,20); and/or (iii) literature indicates a relationship between availability in the home and either diet^(3,21) or obesity^(6,22). Our previous studies also indicated that these items could be reliably and validly collected^(9,10). Within each sub-category, open 'exhaustive' data were collected rather than using a predefined checklist of items (i.e. details on all of the available foods and drinks available were recorded). This method was used as this was an exploratory study with no *a priori* data to suggest the nature or type of foods which were present in the homes of this sample. For fresh produce, researchers recorded the number of whole pieces (e.g. apples) or the number of handfuls (e.g. grapes). For non-fresh items, researchers recorded the number of foods and drinks within pre-specified size ranges of small, medium and large units. These were defined by weight and were based on data previously collected⁽⁹⁾ plus the actual package sizes available to purchase in the UK. For example, tinned vegetables that weighed less than 250 g were defined as small; those weighing between 250 and 450 g were considered to be medium; and any weighing more than 450 g were defined as large.

Foods and drinks in UK homes

Other measures pertinent to these analyses

The majority of demographic data were obtained at recruitment (26–28 weeks of pregnancy) including: household structure; marital status; residence type; educational status; and ethnicity. Maternal smoking behaviour was ascertained at this point to determine whether participants were currently smoking during pregnancy by self-report. All questionnaires were transliterated into Urdu and Mirpuri language, as the majority of Pakistani populations residing in Bradford are of Mirpuri origin and one of the official languages of Pakistan is Urdu. The process of transliteration involved translation, back-translation and several rounds of piloting by bilingual and monolingual groups in collaboration with local experts in Bradford (Bradford Talking Media). Since Mirpuri does not have a written form, transliterations were made available for administration by bilingual study administrators. There were no language restrictions for eligibility into the present study and bilingual staff were trained to collect data from homes in which the parents were unable to speak English.

Data cleaning

Open, exhaustive data from 836 food and drink items that were identified within the homes of this sample were grouped to 215 individual food and drink types by a nutritionist (M.B.). For example, a 'packet of chocolate digestive biscuits' was grouped as 'biscuits with chocolate topping' within the sub-category of 'biscuits/sweet snacks' (under the higher category of snacks). Similarly, all crisps that were made with corn were assigned to the group of 'tortillas' within 'crisps/savoury snacks' and 'red grapes' and 'green grapes' were grouped as 'grapes' within the sub-category of fresh fruits (under the higher category of fruit). For the purpose of these analyses, one handful of fresh produce represented one serving. Other fresh produce that were recorded as whole units (e.g. melons) were converted to the number of servings by a nutritionist (M.B.) using standards provided by NutritionData.com (<http://nutritiondata.self.com/facts>) and the US Department of Agriculture (<http://ndb.nal.usda.gov/ndb/foods>). Scores were generated for the analysis of non-fresh produce based on the number of each food item within predefined sizes. Small items were assigned a score of 1 per item; medium, a score of 2; and large, a score of 3 per item. These can be viewed as equivalent to the total number of small sized items. For example, a score of 4 for tinned vegetables is equivalent to having four small tins of vegetables in the home, even though it may have actually have been available as one large tin (score of 3) plus one small tin (score of 1).

Statistical analysis

Descriptive data (with 95% confidence intervals) presenting the types and quantities of each type of food and drink are provided overall and stratified by ethnicity. General linear regression models (PROC GLM) were then

used to compare mean food and drink availability levels between homes with White British and Pakistani groups only (owing to insufficient numbers in the Other ethnicity category). The LSMEANS option was used to estimate the adjusted mean availability for both ethnic groups. Regression model 1 was unadjusted. Model 2 was adjusted for the total number of people reported to live in each household (un-weighted) as this has been shown to impact on home food availability previously^(10,18) and differs between the White and Pakistani families in this cohort⁽¹⁶⁾. Full covariate adjustment was not deemed necessary here however, given the exploratory nature of the research. Data were analysed using the statistical software package SAS version 9.2.

Results

Sample

Of the 100 participants who agreed to take part, full food availability data were available from ninety-seven homes (whole categories of foods/drinks were missing from three participants' homes). There were similar numbers of White British (n 46, 47%) and Pakistani (n 41, 42%) mothers, with fewer mothers from a combined ethnicity category defined as 'Other' (n 10, 11%). Data from all three ethnic categories are provided for the descriptive, exploratory findings; however, only data from White British and Pakistani mothers were included in analyses comparing ethnic differences in food availability. Fifty-one per cent of mothers were normal weight at the booking appointment (approximately 12 weeks' gestation/pregnant), 29% were overweight ($\text{BMI} \geq 25 \text{ kg/m}^2$) and 17% were obese ($\text{BMI} \geq 30 \text{ kg/m}^2$). Supplemental Table 1 (online supplementary material) shows the participants' characteristics.

Presence/absence of foods/drinks in the home

Table 1 shows the frequency of homes that had at least one item of food or drink available within higher food categories. All homes had at least one type of fruit, at least one type of vegetable and at least one type of snack available. The majority of homes had at least one type of fresh fruit available and this was similar in all ethnicities. Availability of other forms of fruit (i.e. canned, dried and frozen) was less popular; however, around half of all homes had at least one type of canned or dried fruit. Availability of crisps/tortillas was also popular, with 80% and 90% availability in Pakistani and White British homes, respectively. Over 80% of White British and Pakistani homes also had at least one type of sweet biscuit available to them. Approximately 65% of White homes had at least one type of chocolate available, whereas less than 30% of Pakistani homes had chocolate available. Similarly, there were higher percentages of cakes and sweets in White homes. Approximately half of all homes had at least one type of ice cream available and this was similar across

Table 1 Home food availability: frequency (%) of the presence of foods within higher and sub-categories by ethnicity in a sample of families with infants approximately 18 months old from the Born in Bradford birth cohort, UK

Foods in the home	White British (<i>n</i> 46)		Pakistani (<i>n</i> 41)		Other (<i>n</i> 10)		All (<i>n</i> 97)*	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Fruit								
Fresh	41	89.1	40	97.6	10	100.0	91	93.8
Canned/jar/tinned	24	52.2	19	46.3	5	50.0	48	49.5
Dried	28	60.9	22	53.7	5	50.0	55	56.7
Frozen	3	6.5	0	0.0	1	11.1	4	4.1
Total fruit	46	100.0	41	100.0	10	100.0	97	100.0
Vegetables								
Fresh	44	95.7	41	100.0	9	90.0	94	96.9
Canned/jar/tinned	41	89.1	30	73.2	9	90.0	80	82.5
Frozen	39	84.8	33	80.5	9	90.0	81	83.5
Total vegetables	46	100.0	41	100.0	10	100.0	97	100.0
Snacks								
Crisps/tortillas	36	78.3	37	90.2	7	70.0	80	82.5
Sweet biscuits	38	82.6	35	85.4	9	90.0	82	84.5
Salted nuts	2	4.4	2	4.9	1	10.0	5	5.2
Chocolate	30	65.2	11	26.8	4	40.0	45	46.4
Sweets	22	47.8	17	41.5	5	50.0	44	45.4
Cakes	22	47.8	14	34.2	3	30.0	39	40.2
Ice cream	23	50.0	22	53.7	6	60.0	51	52.6
Total snacks	46	100.0	41	100.0	10	100.0	97	100.0
Beverages								
Sweetened drinks†	28	60.9	35	85.4	5	50.0	68	70.1
Unsweetened drinks‡	14	30.4	10	24.4	2	20.0	26	26.8
Total drinks	34	89.5	35	85.4	6	60.0	79	81.4

*Includes Pakistani, White British and Other ethnicities.

†Includes fizzy, sports and sweetened fruit drinks.

‡Unsweetened drinks are diet versions of sweetened drinks.

ethnicities (albeit somewhat lower in homes of 'Other' ethnicities). Approximately 70% of homes had sweetened beverages available, and non-sweetened beverages were found in 27% of all homes.

Availability of individual foods

Figures 1–4 show the average availability of individual foods within the categories of fruit and vegetables by ethnicity. Fresh fruit commonly available in family homes were oranges, bananas, apples, satsumas and grapes. Commonly available fresh vegetables included potatoes, cucumber, tomatoes and carrots. The single greatest non-fresh fruit available in homes was raisins. Within the category of non-fresh vegetables, foods contributing the most were frozen mixed vegetables, tinned tomatoes and tinned peas. Crisps were the most commonly available type of snack food across all ethnic groups (data not shown).

Ethnic comparisons

Table 2 compares the availability of foods and drinks in homes of White British and Pakistani families. These analyses indicate that Pakistani homes had a greater availability of fresh fruits and sweetened drinks compared with White British homes, with more than twice the amount of these items available, even after adjustment for household size. Eighty-five per cent of Pakistani homes had sweetened beverages available, compared with 60%

of White homes. Conversely, the proportion of homes with unsweetened (or 'diet') drinks available to them was lowest in the Pakistani homes (25%) compared with White (31%) and 'Other' ethnicity (78%) homes. Availability of sugar-sweetened beverages in Pakistani homes was equivalent to approximately sixteen cans of fizzy drink per household on average, compared with an average of six in White British homes.

Discussion

Findings from the present exploratory study showed that all homes had some form of fruit and some form of vegetable available in them. More homes had fresh fruits and vegetables available compared with canned, frozen and dried fruits and vegetables. At least one type of snack food was also available in all of the homes in which inventories were conducted. Of these, crisps and biscuits were most likely to be available. Further exploration of the availability of individual foods showed that apples were available in the greatest quantity, with an average of between three and eight apples available in each home. The vegetable that was available in the greatest quantity was potatoes, with an average of approximately eight to twelve servings available in each home. Within non-fresh items, items that were available in the greatest quantities included raisins,

Foods and drinks in UK homes

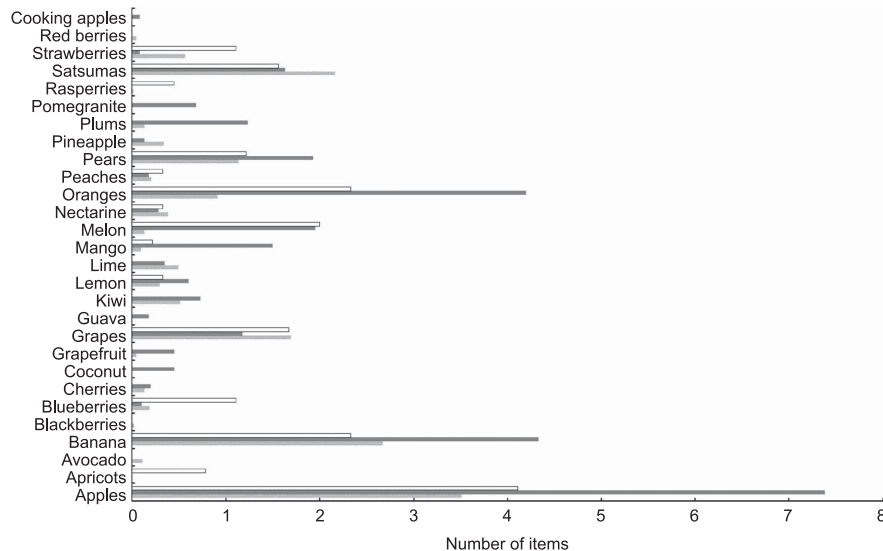


Fig. 1 Home availability of individual fresh fruits by ethnicity (□, Other; ■, Pakistani; ▨, White British) in a sample of families with infants approximately 18 months old from the Born in Bradford birth cohort, UK

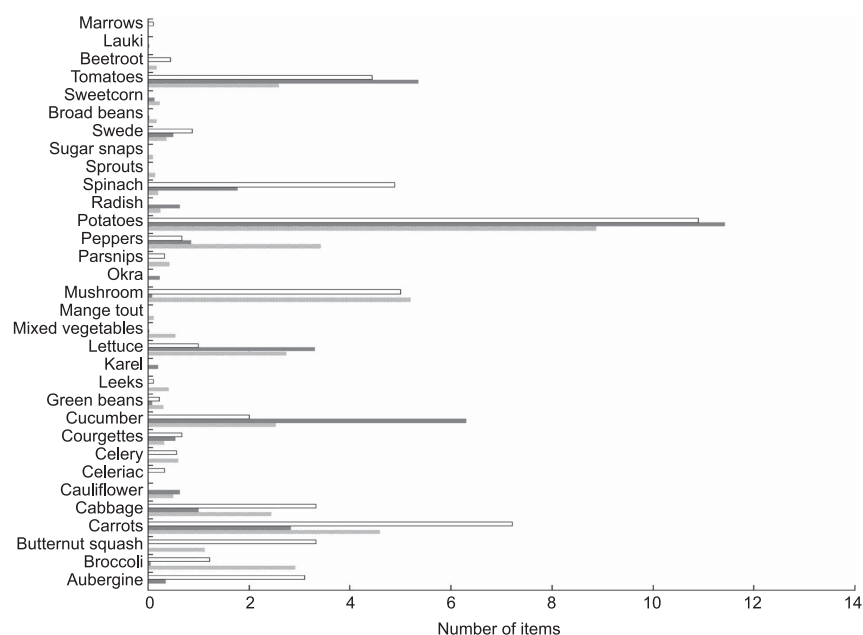


Fig 2 Home availability of individual fresh vegetables by ethnicity (□, Other; ■, Pakistani; ▨, White British) in a sample of families with infants approximately 18 months old from the Born in Bradford birth cohort, UK

frozen mixed vegetables and tinned tomatoes. Ethnic differences between homes of White British and Pakistani participants were found for the availability of fresh fruits and sugar-sweetened beverages, which were both found in higher amounts in Pakistani homes, even after adjustment for household size.

It is difficult to compare these findings with existing data, since there are currently no other comparable contemporary data on foods that are actually available within families' homes in the UK. The UK Office of National Statistics collects self-reported availability by asking families to report availability via purchasing habits.

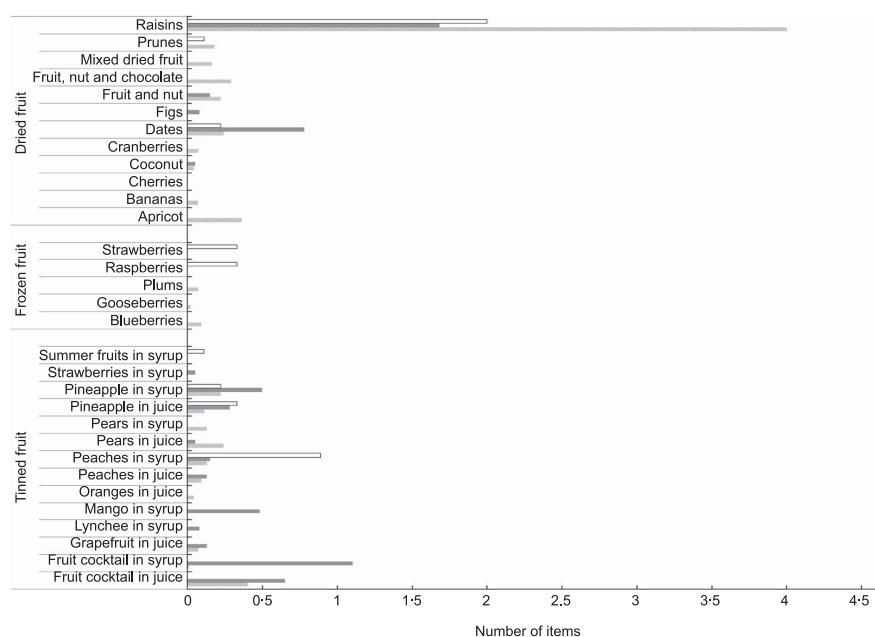


Fig. 3 Home availability of individual non-fresh fruits by ethnicity (□, Other; ■, Pakistani; ▨, White British) in a sample of families with infants approximately 18 months old from the Born in Bradford birth cohort, UK

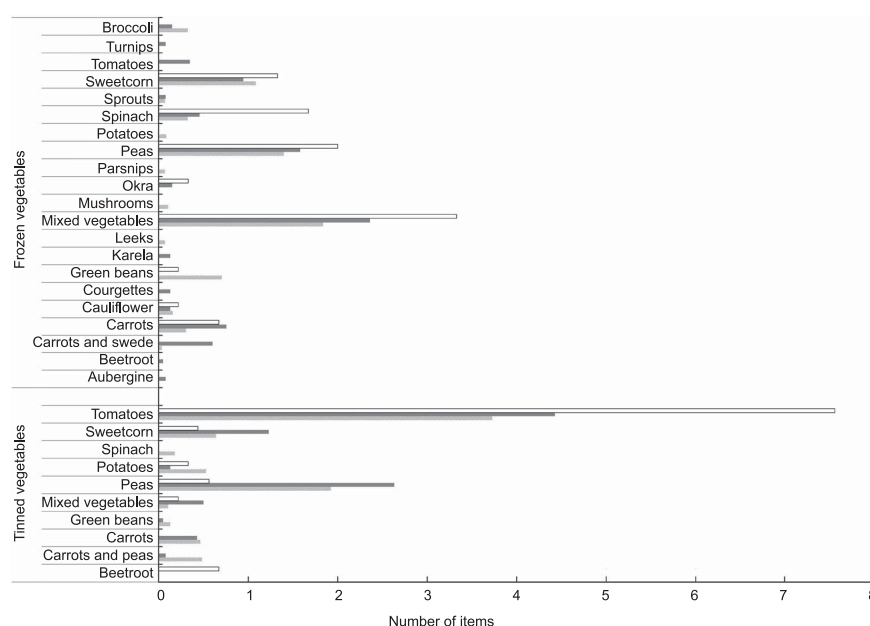


Fig. 4 Home availability of individual non-fresh vegetables by ethnicity (□, Other; ■, Pakistani; ▨, White British) in a sample of families with infants approximately 18 months old from the Born in Bradford birth cohort, UK

These data have been compared with data from other countries and indicate that UK households tend to have higher availability of cereals, but lower availability of fresh fruits and vegetables, than most of the ten other countries.

However, comparisons do not include availability of beverages and they do not indicate differences by participant characteristics⁽²³⁾. A recent study in the USA indicates some differences in home food availability by ethnicity in which

Foods and drinks in UK homes

Table 2 Comparison of home food availability of White British and Pakistani mothers in a sample of families with infants approximately 18 months old from the Born in Bradford birth cohort, UK

	White British (<i>n</i> 46)		Pakistani (<i>n</i> 41)		White British (<i>n</i> 46)		Pakistani (<i>n</i> 41)	
	Unadjusted				Adjusted*			
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Fresh fruit (servings)	15.42†	10.79, 20.04	29.20	24.30, 34.09	16.04†	10.98, 21.09	28.44	23.95, 33.94
Fresh vegetables (servings)	40.39	32.17, 48.61	36.73	28.03, 45.44	40.47	31.47, 49.47	36.63	26.86, 46.41
Tinned fruit	1.59	0.08, 3.10	3.49	1.89, 5.09	1.64	−0.01, 3.30	3.42	1.62, 5.21
Tinned vegetables	9.56	6.25, 12.89	10.93	7.42, 14.43	10.07	6.45, 13.68	10.32	6.39, 14.25
Frozen fruit	0.22	−0.07, 0.50	0.00	−0.30, 0.30	0.21	−0.10, 0.52	0.01	−0.32, 0.35
Frozen vegetables	6.72	4.72, 8.71	7.34	5.23, 9.45	7.02	4.84, 9.20	6.98	4.61, 9.34
Cakes	4.46	1.90, 7.02	4.56	1.85, 7.27	4.99	2.20, 7.78	3.91	0.88, 6.94
Chocolate	7.33	4.59, 10.06	3.17	0.28, 6.07	6.90	3.91, 9.88	3.69	0.45, 6.93
Biscuits	13.57	8.70, 18.43	15.08	9.90, 20.20	14.95	9.67, 20.23	13.36	7.63, 19.10
Ice cream	3.50	1.32, 5.68	4.90	2.59, 7.21	4.41	2.07, 6.75	3.80	1.26, 6.34
Sweetened drinks	5.63†	1.57, 9.67	16.73	12.42, 21.04	6.89†	2.48, 11.29	15.20	10.42, 19.98
Diet drinks	2.35	0.74, 4.00	2.41	0.71, 4.12	2.64	0.88, 4.40	2.06	0.15, 3.97

*Adjusted for total number of members in the household.

† $P < 0.001$ comparing the availability between White British and Pakistani homes.

similar differences to those found here are reported, with a greater availability of fresh vegetables and soft drinks in the homes of Hispanic participants compared with African American homes⁽²⁴⁾. However, these data were collected by self-report. Variability in the methods employed in these studies may well account for inconsistencies in findings. Studies measured using open, researcher-conducted inventories that have been published the last decade (i.e. since the last systematic review of home food availability measures⁽⁸⁾) indicate some differences by weight status⁽²²⁾ and provide evidence of a relationship between availability and dietary intake⁽²⁵⁾. These provide support for the use of such methods in leading towards interventions to encourage optimising the healthfulness of foods and drinks available; however, they do not explore whether findings were dependent on ethnicity and both were conducted in the USA.

The present study indicates that availability of sugar-sweetened beverages (predominantly fizzy drinks) was high in family homes, especially in Pakistani homes, with the equivalent of an average of sixteen cans per household and 85 % having at least one sweetened drink available. Although evidence is not always clear, there is general support that consumption of sugar-sweetened beverages contributes significantly to obesity^(19,26,27). Data from randomised controlled trials support this work, with interventions targeting a reduction in sugar-sweetened beverages showing significant reductions in BMI compared with control groups^(28,29). Further, previous work indicates that this may also be linked to a greater odds of families consuming fast foods as part of their weekly family meals⁽³⁰⁾. Some minority ethnic groups in the UK, including those of Pakistani origin, are more likely to experience poorer health outcomes, such as CVD and type 2 diabetes, compared with the White British population. The aetiology of this is likely to be multifaceted, including the impact of acculturation, genetic predisposition and access/use of health care, which are likely to

impact on diet and other health behaviours. Data from a UK sample of mixed ethnicity showed that Pakistani boys (11–13 years) in particular were more likely to consume 'fizzy' drinks daily compared with White British boys. These data also suggest that Pakistani boys are less likely to meet targets for consuming 5-a-day for fruits and vegetables⁽³¹⁾. These availability data show that homes with participants of Pakistani origin had a higher availability of fresh fruits compared with White British homes. However, they do not provide details of the patterns of consumption by individual family members. Alarmingly, other data (not shown) from the BiB1000 study show a higher consumption of sugar-sweetened beverages in 18-month-old infants born to Pakistani mothers compared with those born to White British parents after adjusting for mother's age and parental education (OR = 2.03; 95 % CI 1.53, 2.70). Consumption of water, however, was similar between infants of different ethnicity (OR = 1.09; 95 % CI 0.84, 1.42).

Seasonality, in terms of the month in which inventories were completed, may have an impact on the foods available. Inventories were conducted every month over the period of 1 year, but there were fewer conducted during August and December due to staffing issues (coinciding with Ramadan and Christmas holidays). The influence of seasonality was considered by re-running analysis with adjustment for the month of data collection and did not change the findings; Pakistani homes had more fresh fruit and sugar-sweetened beverages than White British homes and no other foods were found to differ significantly between ethnicities (data not shown).

The impact of other variables such as socio-economic status on home food availability and their influence on the relationship between food availability and outcomes such as diet and obesity were not the focus of the current study. However, comparisons of food availability by maternal weight status did not identify any clear

relationships (data not shown). Correlations with child BMI were not assessed in the 18-month-old infants but it is possible that the influence of home food availability on diet and BMI is greater in young children compared with adults, who are more likely to eat away from home⁽²⁵⁾. Studies examining the relationship between home food availability and diet or BMI in children report inconsistent findings with variability in the strength of this relationship^(5–7,30,32), although there is general agreement that the relationship is positive (especially for intake of vegetables). Few studies report the impact of socio-economic status. Ding *et al.*⁽⁷⁾ found an influence of household income, with more 'healthy' foods reported in homes with higher incomes. However, their study did not observe a reverse relationship with unhealthy foods. Clearly, more work is required to un-pieced the explanatory factors and mediators that impact on the relationship between foods in the home and diet and health outcomes such as obesity.

Although the present exploratory study has a relatively small sample size, it is comparable (if not greater) to other studies that have collected home food availability data using direct observations by researchers. Previous work indicates that sixty-three households would be required per comparison group to detect a moderate difference of 50 % of 1 SD and only twenty-eight households per group would be needed to detect a difference as large as 75 % of 1 SD (based on one measurement per household)⁽¹⁸⁾. It is possible that other ethnic differences in availability might have been identified with a greater sample size. However, as there are currently no other studies that have measured, in depth, the types of foods and drinks within White British and Pakistani homes in the UK, the aim of the study was more exploratory in order to inform potential targets for the development of future interventions. It could also be argued that, due to the transitory nature of foods in the home (i.e. changing via purchasing and consumption), more than one visit would be required for accurate estimates of availability. Previous evidence actually suggests that the within-household variability of food availability is considerably lower than the between-household variability and that addition of multiple visits does not appreciably impact on estimates⁽¹⁸⁾. A further argument may be that participants changed their shopping habits in advance of the inventories due to social desirability. Following extensive data collection in a different cohort, this was found to be unlikely⁽¹⁰⁾ and when the participants were fully aware of the procedures (i.e. after they had already had completed an inventory), no efforts were made to change the environment for subsequent inventories, as within-house variability was very low⁽¹⁸⁾.

Knowledge of the types and quantities of foods and drinks available in family homes supports the development of targeted intervention programmes wishing to improve the foods available within family homes for obesity prevention or management, or for overall diet improvement. This has the ability to identify population

subgroups at nutritional risk and implement appropriate health promotion and disease prevention programmes. Descriptive data shown here indicate that potential targets might be: (i) promoting the variety, availability and quantity of all types of fruits and vegetables (e.g. encouraging purchase of tinned/frozen fruit in addition to fresh fruit); (ii) reducing purchase of crisps and biscuits (which were both available in over 80 % of homes); and (iii) discouraging purchase of sweetened beverages, especially within homes of Pakistani mothers (in which 85 % of homes had at least one type of sweetened beverage available). This information has been fed into a needs assessment stage of an intervention mapping process in which a culturally appropriate obesity prevention intervention has been developed in Bradford (a city in the north of the UK).

Acknowledgements

Sources of funding: The work was funded by an NIHR CLAHRC implementation grant and an NIHR applied programme grant (RP-PG-0407-10044). This paper presents independent research commissioned by the National Institute for Health Research (NIHR) under the CLAHRC programme. The views expressed are those of the authors and not necessarily those of the National Health Service, the NIHR or the Department of Health. *Conflict of interest:* The authors declare that they have no conflicts of interest. *Authors' contributions:* M.B. designed the study, coordinated data collection, and led analysis and writing of the article. P.S. and A.H. provided expertise in designing the study and contributed to writing the article. G.S. supervised the analysis and contributed to writing the article. *Acknowledgments:* The authors are grateful to all the families who took part in the study, to the midwives for their help in recruiting them, the paediatricians and health visitors, and to the BiB team which included interviewers, data managers, laboratory staff, clerical workers, research scientists, volunteers and managers.

Supplementary material

To view supplementary material for this article, please visit <http://dx.doi.org/10.1017/S1368980014000147>

References

1. Pearson N, Biddle SJ & Gorely T (2008) Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. *Public Health Nutr* **12**, 267–283.
2. Rosenkranz RR & Dziewaltowski DA (2008) Model of the home food environment pertaining to childhood obesity. *Nutr Rev* **66**, 123–140.
3. van der Horst K, Oenema A, Ferreira I *et al.* (2007) A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Educ Res* **22**, 203–226.
4. Rasmussen M, Krolner R, Klepp K-I *et al.* (2006) Determinants of fruit and vegetable consumption among

Foods and drinks in UK homes

- children and adolescents: a review of the literature. Part I: quantitative studies. *Int J Behav Nutr Phys Act* **3**, 22.
5. Arcan C, Hannan PJ, Fulkerson JA *et al.* (2013) Associations of home food availability, dietary intake, screen time and physical activity with BMI in young American-Indian children. *Public Health Nutr* **16**, 146–155.
 6. Boles RE, Scharf C, Filigno SS *et al.* (2013) Differences in home food and activity environments between obese and healthy weight families of preschool children. *J Nutr Educ Behav* **45**, 222–231.
 7. Ding D, Sallis JF, Norman GJ *et al.* (2012) Community food environment, home food environment, and fruit and vegetable intake of children and adolescents. *J Nutr Educ Behav* **44**, 634–638.
 8. Bryant M & Stevens J (2006) Measurement of food availability in the home. *Nutr Rev* **64**, 67–76.
 9. Bryant M, Ward D, Hales D *et al.* (2008) Reliability and validity of the Healthy Home Survey: a tool to measure factors within homes hypothesized to relate to overweight in children. *Int J Behav Nutr Phys Act* **5**, 23.
 10. Stevens J, Bryant M, Wang L *et al.* (2011) Exhaustive measurement of food items in the home using a universal product code scanner. *Public Health Nutr* **14**, 314–318.
 11. Sisk C, Sharkey J, McIntosh W *et al.* (2010) Using multiple household food inventories to measure food availability in the home over 30 days: a pilot study. *Nutr J* **9**, 19.
 12. Krukowski R, Harvey-Berino J & West D (2010) Differences in home food availability of high- and low-fat foods after a behavioral weight control program are regional not racial. *Int J Behav Nutr Phys Act* **7**, 69.
 13. Campbell KJ (2007) Associations between the home food environment and obesity-promoting eating behaviors in adolescence. *Obesity (Silver Spring)* **15**, 719–730.
 14. Hanson N, Neumark-Sztainer D, Eisenberg M *et al.* (2005) Associations between parental report of the home food environment and adolescent intakes of fruit, vegetables and dairy foods. *Public Health Nutr* **8**, 77–85.
 15. Spurrier NJ, Magarey AA, Golley RK *et al.* (2008) Relationships between the home environment and physical activity and dietary patterns of preschool children: a cross sectional study. *Int J Behav Nutr Phys Act* **5**, 31.
 16. Bryant M, Santorelli G, Fairley L *et al.* (2013) The Born in Bradford Childhood Obesity Scientific Group. Design and characteristics of a new birth cohort to study the early origins of childhood obesity: the BiB1000 study. *Longit Life Course Stud* **4**, 119–135.
 17. Wright J, Small N, Raynor P *et al.* (2013) Cohort profile: the Born in Bradford multi-ethnic family cohort study. *Int J Epidemiol* **42**, 978–991.
 18. Stevens J, Bryant M, Wang C-H *et al.* (2012) Sample size and repeated measures required in studies of foods in the homes of African-American families. *J Nutr* **142**, 1123–1127.
 19. Malik VS, Schulze MB & Hu FB (2006) Intake of sugar-sweetened beverages and weight gain: a systematic review. *Am J Clin Nutr* **84**, 274–288.
 20. Nicklas TA, Yang S-J, Baranowski T *et al.* (2003) Eating patterns and obesity in children: the Bogalusa Heart Study. *Am J Prev Med* **25**, 9–16.
 21. Jago R, Page A, Froberg K *et al.* (2008) Screen-viewing and the home TV environment: the European Youth Heart Study. *Prev Med* **47**, 525–529.
 22. Byrd-Bredbenner C & Maurer Abbot J (2009) Differences in food supplies of US households with and without overweight individuals. *Appetite* **52**, 479–484.
 23. Byrd-Bredbenner C, Lagiou P & Trichopoulou A (2000) A comparison of household food availability in 11 countries. *J Hum Nutr Diet* **13**, 197–204.
 24. Skala K, Chuang R-J, Evans A *et al.* (2012) Ethnic differences in the home food environment and parental food practices among families of low-income Hispanic and African-American preschoolers. *J Immigr Minor Health* **14**, 1014–1022.
 25. Bryant M, Stevens J, Wang L *et al.* (2011) Relationship between home fruit and vegetable availability and infant and maternal dietary intake in African-American families: evidence from the exhaustive home food inventory. *J Am Diet Assoc* **111**, 1491–1497.
 26. Pereira MA (2006) The possible role of sugar-sweetened beverages in obesity etiology: a review of the evidence. *Int J Obes (Lond)* **30**, Suppl. 3, S28–S36.
 27. Malik VS, Willett WC & Hu FB (2009) Sugar-sweetened beverages and BMI in children and adolescents: reanalyses of a meta-analysis. *Am J Clin Nutr* **89**, 438–439.
 28. Sichieri R, Yokoo EM, Pereira RA *et al.* (2013) Water and sugar-sweetened beverage consumption and changes in BMI among Brazilian fourth graders after 1-year follow-up. *Public Health Nutr* **16**, 73–77.
 29. James J, Thomas P, Cavan D *et al.* (2004) Preventing childhood obesity by reducing consumption of carbonated drinks: cluster randomised controlled trial. *BMJ* **328**, 1237.
 30. Boutelle KN, Fulkerson JA, Neumark-Sztainer D *et al.* (2007) Fast food for family meals: relationships with parent and adolescent food intake, home food availability and weight status. *Public Health Nutr* **10**, 16–23.
 31. Harding S, Teyhan A, Maynard MJ *et al.* (2008) Ethnic differences in overweight and obesity in early adolescence in the MRC DASH study: the role of adolescent and parental lifestyle. *Int J Epidemiol* **37**, 162–172.
 32. Cullen K, Baranowski T, Klesges L *et al.* (2004) Anthropometric, parental, and psychosocial correlates of dietary intake of African-American girls. *Obes Res* **12**, Suppl., 20S–31S.

Food outlet availability, deprivation and obesity in a multi-ethnic sample of pregnant women in Bradford, UK

Reprinted from *Social Science & Medicine*, vol. 75, Fraser LK, Edwards KL, Tominitz M, Clarke GP, Hill AJ, Food outlet availability, deprivation and obesity in a multi-ethnic sample of pregnant women in Bradford, UK, pp. 1048–56, 2012,¹⁰⁷ with permission from Elsevier.

Social Science & Medicine 75 (2012) 1048–1056



Contents lists available at SciVerse ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed



Food outlet availability, deprivation and obesity in a multi-ethnic sample of pregnant women in Bradford, UK

L.K. Fraser^{a,*}, K.L. Edwards^b, M. Tominitz^a, G.P. Clarke^a, A.J. Hill^c

^a School of Geography, University of Leeds, United Kingdom

^b School of Clinical Sciences, University of Nottingham, United Kingdom

^c Institute of Health Sciences, University of Leeds, United Kingdom

ARTICLE INFO

Article history:
Available online 30 May 2012

Keywords:
Food outlets
Obesity
Ethnicity
Born in Bradford cohort
Deprivation
Fast food

ABSTRACT

The obesogenic environment model would suggest that increased availability or access to energy dense foods which are high in saturated fat may be related to obesity. The association between food outlet location, deprivation, weight status and ethnicity was analysed using individual level data on a sample of 1198 pregnant women in the UK Born in Bradford cohort using geographic information systems (GIS) methodology. In the non South Asian group 24% were obese as were 17% of the South Asian group (BMI > 30). Food outlet identification methods revealed 886 outlets that were allocated into 5 categories of food shops. More than 95% of all participants lived within 500 m of a fast food outlet. Women in higher areas of deprivation had greater access to fast food outlets and to other forms of food shops. Contrary to hypotheses, there was a negative association between BMI and fast food outlet density in close (250 m) proximity in the South Asian group. Overall, these women had greater access to all food stores including fast food outlets compared to the non South Asian group. The stronger association between area level deprivation and fast food density than with area level deprivation and obesity argues for more detailed accounts of the obesogenic environment that include measures of individual behaviour.

© 2012 Elsevier Ltd. All rights reserved.

Introduction

The conceptualisation of an obesogenic environment has changed the way that obesity is viewed and is key to national policy documents to address obesity e.g. (Foresight, 2007). The obesogenic environment model operates on several levels and describes the changes in daily living, transport, and access to recreational facilities, foods and food outlets that have contributed to positive energy balance and weight gain. In this vein, the food industry has come under scrutiny, especially in the ways that fast food is marketed and made available to children and families. A number of US studies have shown that older children who consume greater quantities of fast food are heavier and have greater total energy intakes (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004; Foresight, 2007; Niemeier, Raynor, Lloyd-Richardson, Rogers, & Wing, 2006; Taveras et al., 2005). Similarly, there is longitudinal evidence that increases in fast food consumption are associated with increased weight gain from adolescence to adulthood (Pereira et al., 2005).

It follows that the availability of, or access to food may be related to obesity. This could be via proximity to multiple fast food outlets or the way that people shop at large out of town supermarkets and stockpile food at home may relate to eating habits and obesity. However, supportive evidence is far from compelling even though there has been increasing attention to the location of food outlets, especially those selling fast foods. Evaluations of the relationship between location of fast food outlets and weight status has yielded positive associations (more fast food outlets associated with increased BMI/obesity) in 3 studies (Davis & Carpenter, 2009; Jeffery, Baxter, McGuire, & Linde, 2006; Mehta & Chang, 2008), negative associations in 2 studies (more fast food outlets associated with decreased BMI/obesity) (Morland & Evenson, 2009; Pearce, Hiscock, Blakely, & Witten, 2009), and no association in 4 studies (Burdette & Whitaker, 2004; Casey et al., 2008; Rundle et al., 2009; Wang, Cubbin, Ahn, & Winkleby, 2008). Furthermore, studies that have assessed fast food outlet location and its relationship to fast food and other food consumption have also shown conflicting results (Davis & Carpenter, 2009; Jeffery et al., 2006; Morland & Evenson, 2009; Pearce et al., 2009; Simmons et al., 2005).

In contrast, the relationship between fast food outlet density and deprivation is much clearer. Research from the UK, US and New Zealand has shown higher numbers of fast food outlets in areas of high

* Corresponding author. Room G02, East Building, School of Geography, University of Leeds, Leeds LS2 9JT, United Kingdom.

E-mail address: l.k.fraser@leeds.ac.uk (L.K. Fraser).

deprivation (Block, Scribner, & DeSalvo, 2004; Burns & Inglis, 2007; Cummins, McKay, & MacIntyre, 2005; Fraser & Edwards, 2010; Lewis et al., 2005; Macdonald, Cummins, & Macintyre, 2007; Morland, Wing, Roux, & Poole, 2002; Pearce, Blakely, Witten, & Bartie, 2007; Powell, Chaloupka, & Bao, 2007; Reidpath, Burns, Garrad, Mahoney, & Townsend, 2004; Simon, Kwan, Angelescu, Shih, & Fielding, 2008; Smoyer-Tomic et al., 2008; Zenk & Powell, 2008). Likewise, there is good and longstanding evidence of a relationship between obesity and socioeconomic status, especially in women (Sobal & Stunkard, 1989). Recent consideration of English population data confirms that for women obesity prevalence increases with increasing levels of deprivation, regardless of the way deprivation is measured, and that prevalence of obesity for women in unskilled occupations is twice that of those in professional occupations (NOO, 2010).

There has been relatively little attention paid to whether access to, and the consumption of, fast food are related to ethnicity, outside the US at least, and how this is related to obesity. US studies show, for example, higher intakes of fast foods in non-Hispanic black youth (Bowman et al., 2004), but a recent review of ethnic disparities in obesity risk found no studies in the UK which had assessed predictors of obesity in ethnic subgroups (El-Sayed, Scarborough, & Galea, 2011). This is important information for the UK for two reasons. First, South Asians are at higher risk than the white population for obesity development and associated comorbidities such as coronary heart disease and type 2 diabetes (Misra & Khurana, 2011). Recognising this, lower cut-offs for obesity and abdominal obesity have been proposed for South Asians but without consensus as to exactly what these cut-offs should be. Second, Asian and Asian British are the largest non-white ethnic group in the UK, comprising 4% of the total UK population in the last national census (Census, 2001). Originating mainly from India, Pakistan, and Bangladesh they are concentrated in large urban areas in the UK. Bradford, in the north of England, is typical with South Asians making some 19% of its city population. Many are of Pakistani/Kashmiri origin and are over-represented in poorer inner city areas associated with social and physical deprivation.

We have reported elsewhere on the relationship between fast food outlet geography, deprivation and obesity in children (Fraser & Edwards, 2010). Analysis within another large city in the north of England showed a significant positive correlation between fast food outlet density and deprivation. In addition, fast food outlet density was associated with child obesity even when controlling for deprivation. However, there was no association between distance to the nearest fast food outlet and child obesity. Given the inconsistent results for the existing adult studies of fast food outlet location and obesity (as described above), one of the aims of the present study was to investigate these relationships in a sample of adult women. A further study aim therefore was to investigate the relationships between food outlet access, deprivation and obesity in South Asian and white women and explore any differences between these two groups. This was conducted via a newly recruited birth cohort: the Born in Bradford study (BiB, 2006). Although these participants were pregnant at the time of recruitment their booking weight is a reasonable proxy for pre-pregnancy weight and booking visits normally occur around 12 weeks of gestation in the UK.

Methodologically, studies in this area are challenging. Many rely on telephone interviews and weight is rarely directly measured, often relying on self-report. In addition, the range of food outlets investigated rarely goes beyond the most popular fast food companies and actual food consumption is often not measured. Measuring access to food outlets is also difficult but developments in geographic information systems (GIS) and linkage with population data have permitted developments in spatial analyses.

This study aimed to measure access to all food outlets in part of a northern UK city and investigate the relationship with body

weight, obesity, and small area based deprivation in a multi-ethnic sample of adult women using geographic information systems (GIS) methodology. It was hypothesised that food outlet availability would be related to deprivation and availability would be greater for South Asian participants. In addition, those women who have greater access to food outlets, especially those selling fast foods, would be more likely to be obese.

Methods

Study area

The study area was five contiguous inner city wards in Bradford Metropolitan District Council in the UK. These wards were chosen because they had a range of ethnic population mix (1.2%–63.8% South Asian). There are 8850 wards in total in England and Wales. The population in these wards in Bradford varied from 14,000 to 16,000 (Census, 2001). Although this area in Bradford is predominantly deprived, there is a range of less deprived to very deprived areas within the study area (IMD score range 5.8–75.7) (IMD, 2007). A radius of one ward in each direction was included in order to minimise edge effects in the analysis (see Fig. 1).

Food outlet identification

Food outlet details were obtained from two sources; the Bradford Metropolitan District Council's list of food outlets for health and hygiene purposes (e.g. for licenses/inspections; (Council)) and the Bradford Yellow Pages (index of local businesses). The printed copy of the yellow pages was used as the online version did not contain postcodes. Previous research has shown that using an amalgamation of sources yields a more complete picture when building a GIS model (Pearce et al., 2009).

The accuracy of the data collection was validated by physical 'groundtruthing' a sample of the study area. A random selection of output areas (OAs) (see Data analysis section) were visited to ascertain whether the expected number of food outlets was the same as the actual number; that is, to ensure both that a food outlet existed where the list expected one, and whether there were any additional food outlets over and above what was expected. In order to ascertain the minimum number of OAs to visit to ensure accuracy of over 90% a sample size calculation (Bland, 2000) was undertaken (significance of 0.05). To account for the clustering this sample size was multiplied by the design effect (see below). A sample size of 90 OAs was determined.

$$n = \frac{f(\alpha, P)(\rho_1(1 - \rho_1)) + (\rho_2(1 - \rho_2))}{(\rho_1 - \rho_2)^2}$$

n = sample size
 ρ_2 = proportion in total
 α = significance level
 P = power

$$\text{DEFF} = \frac{a + \frac{b}{m}}{a + b}$$

DEFF = design effect
 a = variance between clusters
 b = variance within clusters.

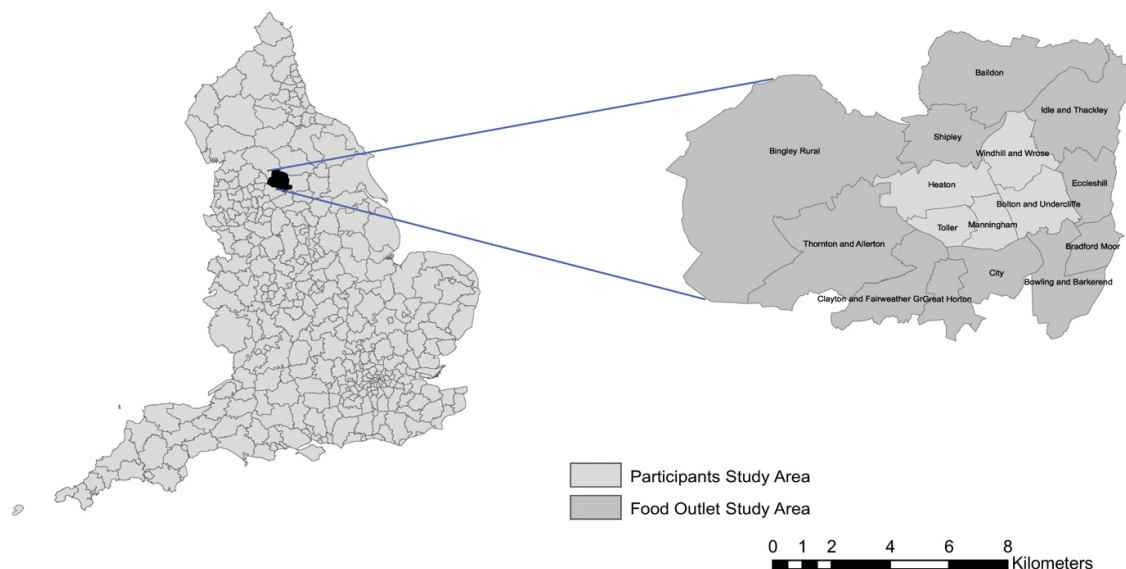


Fig. 1. Bradford study area.

In total, 1271 food outlets were identified in the food outlet study area. There were 819 OAs in the study area which were stratified by deprivation quintile (each OA was linked to their Index of Multiple Deprivation (IMD, 2007) score and then all 819 OAs were ranked and 5 equal quintiles produced). Of these, 90 OAs (15 per quintile) were randomly selected to determine which OAs would be visited. Randomisation was achieved using a random number generator.

In the 90 OAs visited, 148 food outlets were expected and 136 of the expected food outlets were present (i.e. twelve missing). Of these 136, twelve had a new name (but were still trading in the same Food Standards Agency (FSA) category). There were 14 extra outlets (10 in the ground-truthed area and 4 other outlets which were missing from original dataset). This gave an accuracy of 98.6%. The database was updated with the results of the ground-truthing which resulted in 1273 outlets, 15 of which were removed as they

were wholesalers, leaving 1258 outlets. Other outlets whose primary function was not to sell food were removed from the database for analysis (e.g. canteens, pubs). Pubs were removed as it was difficult to determine which of these premises sold food so this may have underestimated food access for the non South Asian population (South Asian women are less likely to use pubs). This resulted in 886 outlets in the final database.

Food outlets were manually re-categorised for mapping and analysis using a combination of the FSA category, outlet name and local knowledge. This resulted in 22 categories which were reduced for analysis into the five categories shown in Fig. 2. The food outlets that sold meals were classified as fast food or 'other eating out'. The other food outlets were separated into supermarkets, specialist food shops which sold a particular food group (e.g. butcher or baker) and retail shops which were smaller shops selling food e.g. convenience stores. The number of food outlets in each category

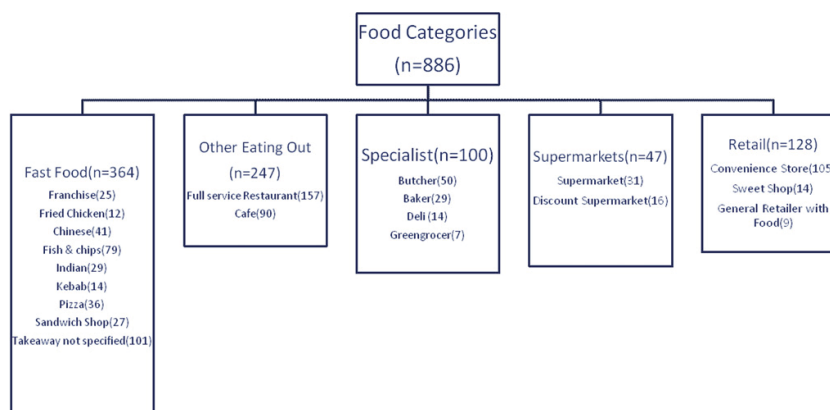


Fig. 2. Food outlet categories for analyses.

was: fast food 364, other restaurants/cafes 246, specialist 100, supermarkets 47 and retail shops 128.

Individual level participant data

Individual data were from participants in the Born in Bradford Study (BiB, 2006). This is a birth cohort that has recruited 13,000 children born in Bradford, UK between 2007 and 2010. The cohort recruited pregnant mothers at 28 weeks of pregnancy. At the time of analysis data were available on a sub-cohort of 1485 women who lived in the study area. These data included age, ethnicity, height, weight at booking of pregnancy and weight at 28 weeks of pregnancy. Booking weight was available for 1198 women who formed the sample for analyses.

Ethnic group was recoded into a binary variable where participants were coded as South Asian or non-South Asian (876 and 322 women respectively). The non South Asian group consisted of 269 (84%) participants who self categorised as white, 27 (8%) other ethnicity, 15 (5%) mixed group, 6 (2%) black and 5 (1%) not known. This allowed for ethnic specific weight status algorithms to be used. Weight at first ante-natal clinic visit (Booking weight) was used as an indicator of pre-pregnancy weight. This weight, along with height, was used to calculate Body Mass Index (BMI) at booking. The BMI was used as a continuous outcome variable and to classify participants as obese or not. The standard BMI > 30 was used for all participants but for the South Asian participants ethnic specific BMI cutoffs were also used to classify the participants as obese or not, recalculating obesity using BMI > 25 (Misra et al., 2009; Who, 2004) in separate analyses. The result tables are all reported for BMI > 30 for both ethnic groups, but any differences in results when using the ethnic specific cut-offs are highlighted in the text. Ethical approval was obtained from the Bradford Research Ethics Committee (Ref 07/H1302/112).

Data analyses

The centroid of the postcode for each food outlet was converted to XY coordinates (using ArcGIS v9.3) in order to allocate each outlet to a Census Output Area (OA) and lower Super Output Area (SOA). These are census geographical areas: an OA contains on average 125 households and SOAs consist of 4–6 OAs. An SOA of residence was assigned to each participant (via postcode of residence) which allowed an Index of Multiple Deprivation code for the area (IMD, 2007) to be assigned to each individual as a proxy for individual level deprivation. Area based measures of deprivation have been shown to show similar associations with health outcomes to individual level measures of deprivation (Smith, Hart, Watt, Hole, & Hawthorne, 1998).

Four measures of food access were used. Firstly, the distance to the nearest food outlet (proximity) in each category for each participant was calculated using ArcGIS v9.3. This allowed for food outlets outside the SOA of residence to be included in the analysis. The distance calculated was straight line (Euclidian) distance. The second method used in the proximity analysis was the number of outlets within each food outlet category in a 250 m, 500 m and 1000 m radius of the individual's residential postcode. This was achieved by the use of buffers in ArcGIS v9.3. Third, the number (density) of food outlets of each category in each SOA was calculated by mapping these outlets (ArcGIS v9.3). Each individual participant was assigned a density number for each category based upon their SOA of residence. Finally, the presence of multiple fast food outlets has been shown to be associated with obesity (Thornton, Bentley, & Kavanagh, 2009). Therefore, further analyses of the fast food outlets were undertaken where clusters of fast food outlets within the study area were identified. A cluster was defined

as postcode areas in which there were 3 or more fast food outlets. Buffers of 250, 500 m and 1000 m of these clusters were created and the proportion of individuals and their obesity status within these buffers were calculated for both ethnic groups.

The statistical analyses were performed at the individual level to avoid the ecological fallacy (where area level results are attributed to individuals but the relationships do not hold at the individual level). First, univariable generalised estimating equation (GEE) models with booking BMI as the outcome and maternal age, deprivation score, food access measure as the independent variables were undertaken for both ethnic groups. Note, these models were run for each of the four different food access measures described above. Next, the independent variables that were significant in the univariable analyses were combined in the multivariable analyses in a forced entry method. Then the univariable generalised estimating equation (GEE) models were repeated but with obesity status as the outcome. Again, the independent variables that were significant in the univariable analyses were combined in the multivariable analyses in a forced entry method. GEE accounts for clustering at SOA level and produces population averaged (marginal) results. All statistical analysis were performed using STATA 10 and statistical significance was set at $p < 0.05$.

Results

In the non-South Asian group, 24% ($n = 78$) were obese and in the South Asian dataset 17% ($n = 149$) were obese (cut off BMI > 25: 46% ($n = 401$) obese; cut-off BMI > 27.5: 29% ($n = 254$) obese). Overall the South Asian group were significantly older (27.7 years vs 26.6 years, $p = 0.001$), had a lower mean BMI (25.3 vs 26.2, $p = 0.02$) and lived in more deprived areas (mean IMD, 2007 49.2 vs 34.5, $p < 0.001$). There was no significant association between deprivation score and BMI in either ethnic group.

Food outlet availability and deprivation

Table 1 shows the correlation coefficients between the level of deprivation (IMD) and the number of food outlets in each category. There were significant positive correlations between deprivation and the number of food outlets of all types and within each buffer distance measure (thus higher deprivation was associated with a higher density of food outlets). There were also significant negative associations between deprivation and the distance from each individual's residence to the nearest outlet in each category of food outlet (thus higher deprivation was associated with living closer to all types of food outlets).

Food access and ethnicity

Table 2 describes the first three food access measures (i.e. the proximity measures and density measure) in the two stratified datasets. The South Asian group had significantly more food outlets in all categories within 250 m, 500 m and 1000 m of residence and also significantly higher food outlet density in the SOA of residence. In addition, the mean distances to all food outlets were smaller for the South Asian group.

Fast food outlet clusters

There were 7 clusters of fast food outlets identified within the study area: 6 clusters had 3 outlets per postcode; one cluster had 4 outlets per postcode; none had more than four. Table 3 shows that as the distance from a cluster of high density fast food (FF) outlets increased the proportion of the South Asian group who were obese

Table 1
Correlation between deprivation and food access.

Type of food outlet	Distance from residence to nearest outlet (m)	Correlation coefficients (IMD score) ^a			
		Number within 250 m of residence	Number within 500 m of residence	Number within 1000 m of residence	Density: number of outlets per SOA
FastFood	−0.38	0.25	0.63	0.72	0.37
Other Restaurant	−0.41	0.42	0.50	0.64	0.24
Retail	−0.44	0.36	0.60	0.76	0.36
Specialist	−0.44	0.25	0.54	0.73	0.30
Supermarket	−0.47	0.13	0.38	0.61	0.34

^a All correlation coefficients $p < 0.001$.

decreased from 19.2% within 250 m of these clusters to 16.0%/16.5% within 750 m/1000 m of these clusters but these differences were not statistically significant ($\chi^2 = 0.11$, $p = 0.73$). A similar trend was seen in the non South Asian group. The highest proportion of obese (24.4%) was found for populations living within 250 m of a FF cluster and the lowest proportion (22.8%) for those within 1000 m; but this was not a linear trend and again this difference is not statistically significant ($\chi^2 = 0.10$, $p = 0.93$).

Predictors of BMI

In the univariable analyses (data available as on online Appendix A) for the non South Asian group, maternal age had the strongest significant association with BMI in this group with BMI increasing by 0.16 units for every year increase in age. Deprivation was not significantly associated with BMI. There were three food access measures with borderline significance: the number of specialist food shops per SOA, the number of specialist food shops within 500 m of the participant's residence, and the number of retail shops within 250 m of the participant's residence. All these food access measures were negatively associated with BMI. The multivariable GEE models with booking BMI as the dependent variable for both groups are shown in Table 4 (including maternal age, deprivation and food access measures which were significant from the univariable analyses).

In the multivariable models which adjusted for age and deprivation score, the number of specialist food shops per SOA was significantly and negatively associated with BMI i.e. one more specialist food shop per SOA was associated with a decrease of 0.75 BMI units (model a). A similar association was shown for the number of 'retail shops' selling food per SOA (model b).

In the univariable analyses (data available as on online Appendix A) for the South Asian Group, maternal age had the strongest significant association with BMI, with BMI increasing by 0.31 units for every year increase in age. Deprivation was not significantly

associated with BMI. There were three food access measures which were significantly associated with BMI: the number of other restaurants per SOA, the number of FF outlets within 250 m of the participant's residence, and the distance to the nearest FF outlet from the participant's residence. The number of 'other restaurants' was negatively associated with BMI, i.e. having an increase in 'other restaurants' was associated with a decreased BMI. The number of FF outlets within 250 m of the participants residence was however also negatively associated with BMI, i.e. more FF outlets was associated with a decreased BMI. This was confirmed with the positive association between the distance to the nearest FF outlet and BMI i.e. the further the participant lived from a FF outlet the higher their BMI.

In the multivariable models for the South Asian group, again adjusting for age and deprivation score, the number of fast food outlets within 250 m of the participant's residence was significantly negatively associated with BMI i.e. one fast food outlet within 250 m of participant's residence was associated with a decrease of 0.18 BMI units (model c). A similar association was shown for the number of retail shops within 250 m of the participants residence (model d) and the significant association with between the distance from residence to the nearest fast food outlet and BMI remained i.e. the further the participant lived from a FF outlet the higher their BMI (model e).

Predictors of obesity

In the univariable analyses (data available as on online Appendix A) for the non South Asian group age and deprivation were not significantly associated with obesity. The number of retail shops and the number of specialist shops per SOA were borderline significantly associated with obesity (negative association).

The multivariable GEE models with obesity status as the dependent variable for both groups are shown in Table 5.

For the non South Asian group (adjusting for age and deprivation), the presence of one more specialist food shop per SOA was associated with a 50% (95%CI: 7–73%) reduction in odds of being

Table 2
Food access measures stratified by ethnic group.

	Distance from residence to nearest outlet(m)		Number within 250 m of residence		Number within 500 m of residence		Number within 1000 m of residence		Density: number of outlets per SOA	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
South Asian (n = 876)										
FastFood	223	151	2.1	2.2	7.3	4.1	24.6	10.9	2.4	2.8
Other Restaurant	283	154	0.8	1.0	3.0	2.8	11.9	9.2	1.3	3.3
Retail	258	196	1.2	1.3	4.0	3.2	12.3	7.0	1.1	1.3
Specialist	294	209	0.9	1.1	3.1	2.5	9.4	5.8	0.9	1.7
Supermarket	675	415	0.2	0.6	0.8	1.1	3.1	2.7	0.3	1.0
Non South Asian (n = 322)										
FastFood	225	138	1.6	1.9	5	3.6	17.5	8.8	2.1	2.0
Other Restaurant	484	304	0.3	0.7	1.3	1.7	7.2	7.5	0.6	1.8
Retail	383	250	0.5	0.7	1.6	1.8	5.7	4.7	0.9	0.9
Specialist	600	336	0.2	0.5	0.7	1.26	2.9	4.1	0.3	0.9
Supermarket	901	367	0.04	0.2	0.2	0.6	1.3	1.7	0.1	0.4

Table 3
Obesity and proximity to a high density cluster of fast food outlets.

Distance from residence to fast food outlet cluster ^a	Asian			Non South Asian		
	Number of participants	Number obese	Percentage obese	Number of participants	Number obese	Percentage obese
250 m	73	14	19.2	45	11	24.4
500 m	245	42	17.1	123	27	21.9
750 m	425	68	16.0	199	47	23.6
1000 m	630	104	16.5	250	57	22.8
Total	876	149	17.0	322	78	24.2

^a Fast food outlet cluster: 3 or more outlets per postcode ($n = 7$).

obese (model f). Having one more retail shop per SOA was associated with a 31% (95%CI: 4–49%) reduction in the odds of being obese (model g). In both these models increased deprivation was significantly associated with being obese.

In the South Asian group, the presence of one more fast food outlet within the SOA of participant's residence was associated with a 6% (95%CI: 2–13%) less chance of being obese (model i). A similar but stronger effect size was shown with an increase of one supermarket within the SOA of participant's residence was associated with a 9% (95%CI: 3–33%) less chance of being obese (model j). A similar association was shown with the presence of a supermarket within 250 m of residence (model k).

When the South Asian group were analysed using the BMI cut-offs of >25 and >27.5 for obesity the results showed (data available as on online Appendix A): for the cut-off BMI >25 , the presence of one more fast food outlet within 250 m of participant's residence was associated with a 6% (95%CI: 1–11%) less chance of being obese. A similar but stronger effect size was shown with an increase of one other restaurant within 250 m of participant's residence being associated with a 16% (95%CI: 4–27%) less chance of being obese.

For the cut-off BMI >27.5 , the presence of one more fast food outlet within 250 m of participant's residence was associated with a 9% (95%CI: 1–17%) less chance of being obese. The presence of one more fast food outlet within the SOA of participant's residence was associated with a 7% (95%CI: 1–13%) less chance of being obese. Due to the relationship between deprivation and food outlet access (Table 2) interaction terms between all food access measures and deprivation were included in the initial multivariable models but were not significant so were removed from the final models.

Discussion

As hypothesised, this study has shown that food outlet availability differs by deprivation and ethnicity. However, the relationship between food outlet access and obesity was in the opposite direction to that hypothesised, although there was some evidence of a relationship between obesity and proximity to clusters of fast food outlets. In addition, there were differences in the associations between food outlet availability and obesity in the two ethnic groups.

The lack of association in either ethnic group between deprivation and BMI or obesity in the majority of the models was unexpected. Within the South Asian participants area level deprivation scores may not be as useful as individual level variables. Individual level variables such as household income were collected in the BiB dataset but had large amounts of missing data, especially within the South Asian group, so could not be used. In the non South Asian group the sample size was small ($n = 322$) and so may have been underpowered to detect a significant effect of deprivation, should one exist. Although area based deprivation measures show similar associations with health outcomes sometimes they can underestimate relationships compared to individual level deprivation measures (Krieger, 1992).

Individuals in higher areas of deprivation had greater access to fast food outlets and to other forms of food shops. The relationship between deprivation and fast food outlets is similar to previous work in the UK (Cummins et al., 2005; Fraser & Edwards, 2010; Macdonald et al., 2007), New Zealand (Pearce et al., 2007) and the US (Block et al., 2004; Morland et al., 2002; Pearce et al., 2007;

Table 4
Multivariable generalised estimating equation models (Gaussian) predicting BMI (non South Asian $n = 322$: model a. Wald $\chi^2 = 15.0$, $p = 0.002$, model b. Wald $\chi^2 = 14.9$, $p = 0.002$; South Asian $n = 876$: model c. Wald $\chi^2 = 87.1$, $p < 0.001$, model d. Wald $\chi^2 = 66.8$, $p < 0.001$, model e. Wald $\chi^2 = 66.3$, $p < 0.001$).

	β coefficient	95% confidence interval		p-value
Non South Asian				
<i>Model a</i>				
Deprivation	0.02	−0.01	0.05	0.16
Number of specialist food outlets per SOA	−0.75	−1.41	−0.09	0.03
Age	0.17	0.06	0.28	0.003
<i>Model b</i>				
Deprivation	0.02	−0.01	0.05	0.14
Number of retail outlets per SOA	−0.67	−1.32	−0.03	0.04
Age	0.17	0.06	0.28	0.002
South Asian				
<i>Model c</i>				
Deprivation	0.02	−0.03	0.04	0.11
Number of fast food outlets within 250 m of residence	−0.18	−0.33	−0.02	0.03
Age	0.32	0.24	0.39	<0.001
<i>Model d</i>				
Deprivation	0.03	0.004	0.04	0.01
Number of retail outlets within 250 m of residence	−0.30	−0.54	−0.05	0.02
Age	0.32	0.24	0.39	<0.001
<i>Model e</i>				
Deprivation	0.02	−0.003	0.04	0.08
Distance from residence to nearest fast food outlet	0.68	0.10	1.27	0.02
Age	0.31	0.24	0.39	<0.001

Table 5

Multivariable generalised estimating equation (Logistic) models predicting obesity status (**non South Asian** $n = 322$: model f. Wald $\chi^2 = 8.9$, $p = 0.03$, model g. Wald $\chi^2 = 7.9$, $p = 0.04$, model h. Wald $\chi^2 = 10.9$, $p = 0.01$; **South Asian** $n = 876$: model i. Wald $\chi^2 = 37.9$, $p < 0.001$, model j. Wald $\chi^2 = 44.6$, $p < 0.001$, model k. Wald $\chi^2 = 40.9$, $p < 0.001$).

	Odds ratio	95% Confidence Interval	p-value
Non South Asian			
<i>Model f</i>			
Deprivation	1.01	0.99 1.03	0.05
Number of specialist food outlets per SOA	0.50	0.27 0.93	0.03
Age	1.03	0.98 1.08	0.19
<i>Model g</i>			
Deprivation	1.01	1.00 1.03	0.05
Number of retail outlets within SOA	0.69	0.51 0.96	0.02
Age	1.04	0.99 1.09	0.13
<i>Model h</i>			
Deprivation	1.01	0.99 1.02	0.12
Number of supermarkets per SOA	0.60	0.47 0.84	0.003
Age	1.04	0.99 1.09	0.12
South Asian			
<i>Model i</i>			
Deprivation	1.01	0.99 1.02	0.09
Number of fast food outlets per SOA	0.93	0.87 0.98	0.01
Age	1.10	1.06 1.15	<0.001
<i>Model j</i>			
Deprivation	1.01	0.99 1.02	0.11
Number of supermarkets per SOA	0.81	0.67 0.97	0.03
Age	1.10	1.06 1.15	<0.001
<i>Model k</i>			
Deprivation	1.01	0.99 1.02	0.19
Number of supermarkets within 250 m of residence	0.76	0.57 1.00	0.05
Age	1.10	1.06 1.15	<0.001

Reidpath et al., 2004; Zenk & Powell, 2008). Interestingly, the greater access to food shops in general is contrary to previous work on 'food deserts' (Wrigley, 2002) where areas of higher deprivation were shown to have poorer access to food shops especially those selling 'healthier' foods.

The relationship between fast food outlet access (number within 250 m of residence) and BMI in the South Asian group was in the opposite direction to that hypothesised. Namely, there was a negative association between BMI and fast food outlet density in close (250 m) proximity. This relationship was also seen for obesity status i.e. more fast food outlets within the SOA of the residence being associated with a lower likelihood of being obese. This could be an example of increased access not necessarily being related to increased consumption i.e. living next to a fast food outlet does not mean that a participant eats in that outlet. Unfortunately there was no fast food consumption data available for this cohort. This South Asian group also showed a negative association between the number of supermarkets and likelihood of obesity. Since the foods available for purchase tend to be more extensive and offer a wider variety of foods, the option of healthier alternatives is possible. Again however no consumption data were available for these participants. The use of BMI as an outcome measure may also explain some of these null findings. It has been shown in South Asian adults that waist-to-height ratios or measures of body fat such as DEXA scanning correlate better with adverse health outcomes related to obesity (e.g. hypertension)(El-Sayed et al., 2011).

Analysis of data from the non South Asian group revealed no significant association between BMI or obesity and access to fast food outlets or other restaurants. The observed significant association in this group was access to specialist food shops (butchers,

delis, greengrocers). The presence of one more specialist food shops within the SOA of residence was associated with a lower BMI and a 50% less chance of being obese. Specialist food shops, as defined in this study, generally offer the option of healthy foods such as fruit and vegetables, making this association plausible. Interestingly, the relationship with the number of retail shops per SOA was similar in this group. Retail shops include convenience stores which sell less healthy foods but often also offer healthier alternatives.

The direct comparison of the ethnic groups in terms of food outlet access was unable to account for differences in purchasing behaviours between the two ethnic groups. There is no current literature from the UK describing whether the South Asian population in the UK frequent fast food outlets and restaurants in similar patterns to the White population. A proportion of the participants were first generation migrants to the UK and may not have developed western shopping and eating out practices. Again, food consumption information may have been helpful to assess this.

In this dataset more than 95% of the participants lived within 500 m of a fast food outlet so it is perhaps not surprising that the expected direction of association was not seen in the analyses. This degree of saturation has not been demonstrated previously but may be characteristic of inner cities currently in the UK. The relationships between proximity to the largest cluster of fast food outlets and the proportion of each group who were obese was in line with expectations. This analysis did describe the hypothesised association with the highest proportion obese in both groups living within 250 m of a cluster of fast food outlets. It should be noted that previous work from Australia has also shown a positive association between obesity and the presence of/access to more than one fast food chain (Thornton et al., 2009).

This study has strengths and limitations. It was a cross sectional study so no causal inference can be made. There is also no food consumption data available and previous research has shown mixed results on the relationship between increased access to fast food outlets and fast food consumption (Pearce et al., 2009; Thornton et al., 2009). The booking BMI was only available for 81% of the participants. Booking weight is a reasonable proxy for pre-pregnancy weight and booking visits normally occur around 12 weeks of gestation in the UK. However, there may be some participants who were seen for booking visits later in pregnancy and this may differ by ethnicity. In addition, there were several measures of access used in this study including number of outlets per SOA which are subject to artificial boundary effects i.e. ignores the density in adjacent SOAs, and food outlets in these areas are possibly closer/easier to access. We did use buffers around residences and had sampled our food outlets from extra wards surrounding the study area to prevent the edge effects. Using Euclidian distance to measure access to nearest outlet is not ideal as this does not take into account street (network) distance and barriers to access e.g. rivers (Clarke, Eyre, & Guy, 2002). In addition, there are many other potential confounding factors in the relationship between food access and obesity including physical activity levels, access to car(s) and food costs that have not been adjusted for in these analyses due to lack of available data. This study was only of pregnant women and these findings may not be relevant to the male population especially within the South Asian population where the male role in society differs greatly from the female. The use of area based deprivation measures rather than individual deprivation measures may have underestimated associations between deprivation and weight status in this dataset.

As far as we are aware at the time of writing, this study is the first to address possible ethnic differences in these issues in the UK. The debate over South Asian specific obesity cut-offs is ongoing (Misra et al., 2009; Who, 2004). It is of note that the results of the food outlet analyses did differ when the different BMI cut-offs for

obesity in the South Asian group were used (e.g. one extra fast food outlet was associated with a 6% less chance of being obese using the standard BMI cut-off (BMI > 30) but this changed to a 7% less chance of being obese when a lower cut-off was used (BMI > 25)). Importantly the direction of associations did not change. There is also debate over the use of BMI as a predictor of the consequences of obesity within the South Asian population and whether other measures such as body fat and waist to height ratio are more useful predictors. Waist measurements in pregnancy are not useful and body fat data was not collected in the mothers in the BiB cohort.

In conclusion, this study has highlighted the degree of exposure to food outlets, especially fast food outlets, within the city of Bradford and especially within a sub-group of the South Asian community. This is strongly linked with measured deprivation. Accordingly, it is an important factor for planning authorities to assess when applications for further food outlets are made. In Los Angeles there has been a recent ban on the opening of new fast food outlets in the most deprived areas. Further research is required to incorporate other constituents of the obesogenic environment such as transport and green spaces to assess the interplay between individuals and their environment. In addition, these types of analyses would benefit from the inclusion of measures of purchasing behaviour and activity level.

Funding

This report/article* presents independent research commissioned by the National Institute for Health Research (NIHR) under 'Development and evaluation of interventions for the prevention of childhood obesity in a bi-ethnic Population: the Born in Bradford NHS Research Programme.'

The views expressed in this publication* are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health.

Acknowledgements

We are grateful to all the families who took part in this study, to the midwives for their help in recruiting them, the paediatricians and health visitors and to the Born in Bradford team which included interviewers, data managers, laboratory staff, clerical workers, research scientists, volunteers and managers.

Appendix A. Supporting information

Supplementary information associated with this article can be found, in the online version, at doi:10.1016/j.socscimed.2012.04.041.

References

- BiB. (2006). *Born in Bradford Cohort Study*.
- Bland, M. (Ed.). (2000). *An introduction to medical statistics*. Oxford University Press.
- Block, J. P., Scribner, R. A., & DeSalvo, K. B. (2004). Fast food, race/ethnicity, and income – a geographic analysis. *American Journal of Preventive Medicine*, 27, 211–217.
- Bowman, S. A., Gortmaker, S. L., Ebbeling, C. B., Pereira, M. A., & Ludwig, D. S. (2004). Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics*, 113, 112–118.
- Burdette, H. L., & Whitaker, R. C. (2004). Neighborhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. *Preventive Medicine*, 38, 57–63.
- Burns, C. M., & Inglis, A. D. (2007). Measuring food access in Melbourne: access to healthy and fast foods by car, bus and foot in an urban municipality in Melbourne. *Health & Place*, 13, 877–885.
- Casey, A. A., Elliott, M., Glanz, K., Haire-Joshu, D., Lovegreen, S. L., Saelens, B. E., et al. (2008). Impact of the food environment and physical activity environment on behaviors and weight status in rural US communities. *Preventive Medicine*, 47, 600–604.
- Clarke, G., Eyre, H., & Guy, C. (2002). Deriving indicators of access to food retail provision in British cities: studies of Cardiff, Leeds and Bradford. *Urban Studies*, 39, 2041–2060.
- Council, B. M. Bradford Metropolitan District Council. www.bradford.gov.uk Accessed 01.10.09.
- Cummins, S. C. J., McKay, L., & MacIntyre, S. (2005). McDonald's restaurants and neighborhood deprivation in Scotland and England. *American Journal of Preventive Medicine*, 29, 308–310.
- Davis, B., & Carpenter, C. (2009). Proximity of fast-food restaurants to schools and adolescent obesity. *American Journal of Public Health*, 99, 505–510.
- El-Sayed, A., Scarborough, P., & Galea, S. (2011). Ethnic inequalities in obesity among children and adults in the UK: a systematic review of the literature. *Obesity Reviews*, 12, e516–e534.
- Foresight. (2007). *Tackling obesities: The Foresight report*.
- Fraser, L. K., & Edwards, K. L. (2010). The association between the geography of fast food outlets and childhood obesity rates in Leeds, UK. *Health & Place*, 16, 1124–1128.
- IMD. (2007). *Index of multiple deprivation 2007*.
- Jeffery, R. W., Baxter, J., McGuire, M., & Linde, J. (2006). Are fast food restaurants an environmental risk factor for obesity? *International Journal of Behavioral Nutrition and Physical Activity*, 3, 2.
- Krieger, N. (1992). Overcoming the absence of socioeconomic data in medical records – validation and application of a census-based methodology. *American Journal of Public Health*, 82, 703–710.
- Lewis, L. B., Sloane, D. C., Nascimento, L. M., Diamant, A. L., Guinard, J. J., Yancey, A. K., et al. (2005). African Americans' access to healthy food options in South Los Angeles restaurants. *American Journal of Public Health*, 95, 668–673.
- Macdonald, L., Cummins, S., & Macintyre, S. (2007). Neighbourhood fast food environment and area deprivation-substitution or concentration? *Appetite*, 49, 251–254.
- Mehta, N. K., & Chang, V. W. (2008). Weight status and restaurant availability – a multilevel analysis. *American Journal of Preventive Medicine*, 34, 127–133.
- Misra, A., Chowbey, P., Makkar, B. M., Vikram, N. K., Wasir, J. S., Chadha, D., et al. (2009). Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management. *Journal of the Association of Physicians of India*, 57, 163–170.
- Misra, A., & Khurana, L. (2011). Obesity-related non-communicable diseases: South Asians vs White Caucasians. *International Journal of Obesity*, 35, 167–187.
- Morland, K. B., & Evenson, K. R. (2009). Obesity prevalence and the local food environment. *Health & Place*, 15, 491–495.
- Morland, K., Wing, S., Roux, A. D., & Poole, C. (2002). Neighborhood characteristics associated with the location of food stores and food service places. *American Journal of Preventive Medicine*, 22, 23–29.
- Niemeier, H. M., Raynor, H. A., Lloyd-Richardson, E. E., Rogers, M. L., & Wing, R. R. (2006). Fast food consumption and breakfast skipping: predictors of weight gain from adolescence to adulthood in a nationally representative sample. *Journal of Adolescent Health*, 39, 842–849.
- NOO. (2010). *Adult obesity and socioeconomic status*.
- Office for National Statistics. (2001). *Census: Standard area statistics (England and Wales)* [computer file]. ESRC/JISC Census Programme, Census Dissemination Unit, Mimas (University of Manchester)/Centre for Interaction Data Estimation and Research (University of Leeds).
- Pearce, J., Blakely, T., Witten, K., & Bartie, P. (2007). Neighborhood deprivation and access to fast-food retailing – a national study. *American Journal of Preventive Medicine*, 32, 375–382.
- Pearce, J., Hiscock, R., Blakely, T., & Witten, K. (2009). A national study of the association between neighbourhood access to fast-food outlets and the diet and weight of local residents. *Health & Place*, 15, 193–197.
- Pereira, M. A., Kartashov, A. I., Ebbeling, C. B., Van Horn, L., Slattery, M., Jacobs, D. R., et al. (2005). Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *Lancet*, 365, 36–42.
- Powell, L. A., Chaloupka, F. J., & Bao, Y. J. (2007). The availability of fast-food and full-service restaurants in the United States – associations with neighborhood characteristics. *American Journal of Preventive Medicine*, 33, S240–S245.
- Reidpath, D. D., Burns, C., Garrard, M., Mahoney, M., & Townsend, M. (2004). An ecological study of the relationships between social and environmental determinants of obesity. *Health & Place*, 8, 141–145.
- Rundle, A., Neckerman, K. M., Freeman, L., Lovasi, G. S., Purciel, M., Quinn, J., et al. (2009). Neighborhood food environment and walkability predict obesity in New York City. *Environmental Health Perspectives*, 117, 442–447.
- Simmons, D., McKenzie, A., Eaton, S., Cox, N., Khan, M. A., Shaw, J., et al. (2005). Choice and availability of takeaway and restaurant food is not related to the prevalence of adult obesity in rural communities in Australia. *International Journal of Obesity*, 29, 703–710.
- Simon, P. A., Kwan, D., Angelescu, A., Shih, M., & Fielding, J. E. (2008). Proximity of fast food restaurants to schools: do neighborhood income and type of school matter? *Preventive Medicine*, 47, 284–288.
- Smith, G. D., Hart, C., Watt, G., Hole, D., & Hawthorne, V. (1998). Individual social class, area-based deprivation, cardiovascular disease risk factors, and mortality: the Renfrew and Paisley study. *Journal of Epidemiology and Community Health*, 52, 399–405.
- Smoyer-Tomic, K. E., Spence, J. C., Raine, K. D., Amrhein, C., Cameron, N., Yassenovskiy, V., et al. (2008). The association between neighborhood socioeconomic status and exposure to supermarkets and fast food outlets. *Health & Place*, 14, 740–754.

- Sobal, J., & Stunkard, A. J. (1989). Socioeconomic-status and obesity – a review of the literature. *Psychological Bulletin*, 105, 260–275.
- Taveras, E. M., Berkey, C. S., Rifas-Shiman, S. L., Ludwig, D. S., Rockett, H. R. H., Field, A. E., et al. (2005). Association of consumption of fried food away from home with body mass index and diet quality in older children and adolescents. *Pediatrics*, 116, E518–E524.
- Thornton, L. E., Bentley, R. J., & Kavanagh, A. M. (2009). Fast food purchasing and access to fast food restaurants: a multilevel analysis of ViCLANES. *International Journal of Behavioral Nutrition and Physical Activity*, 6.
- Wang, M. C., Cubbin, C., Ahn, D., & Winkleby, M. A. (2008). Changes in neighbourhood food store environment, food behaviour and body mass index, 1981–1990. *Public Health Nutrition*, 11, 963–970.
- Who. (2004). Appropriate body-mass index in Asian populations and its implications for policy and intervention strategies (vol. 363, p. 157, 2004). *Lancet*, 363, 902.
- Wrigley, N. (2002). 'Food deserts' in British cities: policy context and research priorities. *Urban Studies*, 39, 2029–2040.
- Zenk, S. N., & Powell, L. M. (2008). US secondary schools and food outlets. *Health & Place*, 14, 336–346.

Appendix 4 Born in Bradford and the Twins Grow Up

Photographs Ian Beesley, poems Ian McMillan. Copyright permissions for the poems and photographs are held by Born in Bradford and permission to reproduce here has been granted. All photographs are used with the written consent of parents.



BORN IN BRADFORD

You're awake

You're here

In this light

This Bradford light

A town built on the softness of wool and water

Feels like a good place to be born in.

The hills protect you, and the rain seems to whisper so quietly

That you hardly notice it. But it's there. Falling like history.

You turn your face to the light, and let's face it

The boom that sustained this place has folded like cloth

Folded and put into a drawer like babies were once,

When a cot was a luxury you couldn't afford.

You're awake

You're here
 In this light
 This Bradford light
 And now you're crying. You're filling your lungs
 With West Yorkshire air and pushing it out
 In long notes and short notes; and listen: those notes
 Are pushing their way into a future that none of us can hear
 A future that will undoubtedly be yours,
 In the soft rain and the gorgeous Bradford stone
 That has seen laughing times and shattered times,
 The morning pram and the afternoon hearse.
 You're awake
 You're here
 In this light
 This Bradford light
 And now you're sleeping; you're smiling in your sleep,
 And sometimes you sigh like a long breeze from the hills
 And nobody knows what's waiting inside you: the cough,
 The fear of spaces, the joy of running faster and faster,
 The hands that look like your father's hands,
 The way you shape your sentences so you sound
 Like your grandma, the crisps on the bib,
 The way you seem to be born to laugh and laugh,
 The way you always get any cold that's going,
 Catch it like a net catches a fish, the way the first pint
 Will always lead to the sixth and the bag of chips
 The way all these things will happen, will happen
 Unless we enfold you
 Like the wool that once enfolded this city.
 You're awake, You're here
 In this light, This Bradford light

BIRTHDAY CARDS



Dawoud & Ishaq

Happy First Birthday, Born in Bradford!

Come sing a birthday song with me
A birthday song of greeting

Welcome to all babies born in Bradford:
Not too loud; little 'un's sleeping!

Come dance a birthday dance with me;
A birthday dance of joy
Celebrate the babies born in Bradford
She's daddy's little girl; he's mum's little boy!

And in the middle of the night when you're wide awake

Just smile and have a bite of the birthday cake!

Happy Second Birthday, Born in Bradford!

She's kicking her legs because she wants to run,
He's leaning forward to hear the news.
Both living in a world of songs and fun:
The simple sun shines and the sky is blue.

And in years to come this sister and brother
Will hear their twin cry and feel them laugh
Even if there's a distance, one from the other,
They're always side by side, like in this photograph



George & Grace



Dawoud & Ishaq

Happy Third Birthday, Born in Bradford!

Three new stars in the Bradford sky
 Three new smiles on the face of the earth
 Three new lives getting ready to fly
 One huge gift of great worth...

Three new people who begin to grow
 Three new smiles on the earth's broad face
 Three new dancers in a lifelong show
 One set of runners in the human race...

Happy Fourth Birthday, Born in Bradford!

Four years: that's sixteen seasons,
 Four Summers and Four springs
 Four years and sixteen reasons
 To celebrate children, delight in twins;
 Four Winters and four Autumns;
 Think what just four years have taught 'em...

And here's to the next amazing four
 Let's run to the future and open the door!



George & Grace



Dawoud & Ishaq

Happy Fifth Birthday, Born in Bradford

Now the journey of learning begins:
 Wide eyes and hopeful grins
 five years of experience, sensible shoes,
 a new chapter ahead and new skills to use...

Now the journey of life carries on,
 An endless, developing song;
 Five years of growing, in body and mind
 And the long road ahead unfurls and unwinds...

Happy Sixth Birthday, Born in Bradford!

It's six of one
 And half a dozen of the other;
 The eggs in a basket
 The sister, the brother

The six years here
 On the Bradford earth
 The six short years
 Flown since the birth

That gave us these faces
 Shining with joy
 The three times two
 The girls, the boys.

Happy birthday
 Six years old
 Stretch your wings
 Let life unfold!



George & Grace



Dawoud & Ishaq

Happy Seventh Birthday, Born in Bradford!

Another birthday's come round.
 A year turns like a ring:
 Fourteen feet on the ground
 Seven voices to sing.

Another birthday's come round.
 Life circles and spins
 With the sight and the sound
 As the singing begins:

'Another birthday's come round
 Life leaves on a tree.
 Come, see what we've found
 You're growing, like me!'

Happy Eighth Birthday, Born in Bradford!

They gather the years
 In handfuls like flowers
 Laughter and tears
 And thousands of hours

And hundreds of weeks
 And months by the score
 Each one unique.
 Now open the door

To the glorious eight
 All these sets of two
 Who really can't wait

To share their world with you!



George & Grace

My Daddy's Hands

My daddy's hands

Will carry me forever;

The gentle echo of his fingerprints

Are part of the way I will be

Are much of the way I am.

My daddy's hands

Will carry me forever

Or until my hands

Carry him.



Sidra

A decorative graphic consisting of numerous thin, parallel green lines that curve from the left side of the page towards the right, creating a sense of movement and depth.

EME
HS&DR
HTA
PGfAR
PHR

Part of the NIHR Journals Library
www.journalslibrary.nihr.ac.uk

This report presents independent research funded by the National Institute for Health Research (NIHR). The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health

Published by the NIHR Journals Library